

Annual Report

1958.....

LAKE STATES FOREST EXPERIMENT STATION
FOREST SERVICE - U.S. DEPARTMENT OF AGRICULTURE

The Lake States Forest Experiment Station is one of nine regional forest research stations administered by the Forest Service, U. S. Department of Agriculture. It is maintained in cooperation with the University of Minnesota. Through Federal legislation, it is authorized to carry on forest research for the benefit of all forestry agencies in the region, including public forestry groups, wood-using industries, and other forest owners.

The territory in which the Station operates includes the Lake States (Michigan, Wisconsin, and Minnesota) and the Northern Great Plains. Besides the Station headquarters in St. Paul, field offices are located at East Lansing and Marquette, Mich.; LaCrosse, Rhinelander, and Wausau, Wis.; Grand Rapids, Minn.; and Bottineau, N. Dak.

ANNUAL REPORT

of the

LAKE STATES FOREST EXPERIMENT STATION

for the year 1958

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Annual Report *of the* *Lake States Forest Experiment Station* *1958*

Introduction

At the beginning of each new year the Station pauses for a moment of introspection--a checkup on the past year's progress. As we look back, in numerous ways 1958 was a period of sustained growth; of reemphasis on the importance and place of research in the rural economy of forested areas; of renewed recognition that, while "space exploration" is enormously expanding our horizons, the employment and well-being of millions of people still largely depend on how well the full productiveness of forest land is attained. This down-to-earth aspect of a natural resource presents a tremendous challenge. In some ways we are meeting this challenge; in others, there is an urgent need to get on with the job more rapidly.

A year ago our annual report summarized research efforts in the field of reforestation--what has been done and what is being done to make forest land more productive. This year we summarize briefly what we are doing in many fields of forest research. A few of the most significant developments Stationwide are mentioned in the following paragraphs. Then the six divisional programs are given in greater detail.

To meet the critical need for research facilities--laboratory space and equipment--funds were appropriated for two field laboratories. One will be at Grand Rapids, Minn., to house the field staff there and to provide laboratory space for work on forest soils, silviculture, and related fields. The second laboratory will be at Rhinelander, Wis., and will be a major addition to the Northern Institute of Forest Genetics.

In recognition of the complex land-use and watershed problems in southwestern Wisconsin and southeastern Minnesota, a research program was reactivated in that area. With headquarters at La Crosse and in cooperation with the Wisconsin Conservation Department, the immediate objective will be to conduct watershed management research on nonglaciated forested lands where rapid runoff and erosion problems are critical. An experimental area is being purchased by the Wisconsin Conservation Department. Thus, research activities initiated in the thirties will once again move forward in that part of the Lake States region.

With substantial financial assistance of three industry trade associations, a maple blight survey and research project was launched early in 1958. To date it appears that the blight does not intensify as alarmingly as was feared. It still, though, presents an unknown of serious proportions. The Station, the University of Wisconsin, and the State forestry organizations of Wisconsin and Michigan all worked together closely in collecting data and in analyzing all clues as to the cause and potential for future damage. Dr. Ralph Anderson, Chief of the Station's Forest Disease Division, is coordinating the surveys and research on this project.

The European pine shoot moth and the spruce budworm continue to cause extensive damage to coniferous trees. In both instances greater emphasis was given to life studies and ecological relationships. An exploratory study of insects related to Hypoxylon canker was initiated.

The Northern Plains shelterbelt research program was strengthened in 1958 and now has a staff of three. Current emphasis in the research program is on planting sites, nursery problems, and tree improvement studies.

At the Northern Institute of Forest Genetics, in addition to the planning for new laboratory facilities, the program is being broadened to include hardwood species. Tree improvement research for the Northern Plains will be centered at the Institute too.

Publication of research findings continued to keep abreast of data analysis. Some 95 publications were released during the year. These are listed in the back of this report.

In numerous other ways research activities are being brought to the public. Through show-me trips, talks at public gatherings, and in training sessions and conferences for professional groups, Station staff members are telling of their work. Some of the more important meetings sponsored by the Station this year were the Central International Forest Insect and Disease Conference at the Kawishiwi Experimental Forest near Ely, Minn.; several training sessions for professional foresters on identification of superior trees and stands; a meeting for those interested in charcoal research at the Station's charcoal kiln installations at Three Lakes, Wis., and Marquette, Mich.; and the Annual Meeting on Insect Survey Techniques.

Although progress in research is largely the result of the joint efforts of many people, scientists of outstanding ability and fertile imagination lead the way. Among these leaders was Suren R. Gevorkiantz, mathematical statistician, who died on May 8, 1958, after 32 years of service to the Station and to the forestry profession generally. Mr. Gevorkiantz was an expert in the estimation of forest resource, growth, and mortality; forest measurement; and experimental design. His help was eagerly sought and was generously given to scientists in many fields of work. The Station staff take this opportunity to pay tribute to his memory.

M. B. Dickerman

M. B. DICKERMAN, Director

Forest Economics

J. T. Morgan, Division Chief

The Station's work in forest economics research continued to increase public knowledge of forest resources and to explore the financial problems of growing and marketing forest products. As in previous years, a large part of the effort was devoted to the Forest Survey, which gathers and analyzes statistics on forest area, timber volume, growth, natural mortality, and timber cutting. Several improvements in technique were tested and approved, while substantial progress was made in field surveys and in preparing reports for publication. New studies were begun in the fields of forest taxation and the attitudes of forest landowners. Marketing studies begun 2 and 3 years ago were completed and the data analyzed.

Progress of the Forest Survey

The primary responsibility of the Forest Survey is to make, and keep current, information on the Nation's forest resources. Authorized in 1928 by Congress, the first complete field inventory of the Lake States was begun in 1933 and completed in 1937. This was a line-plot cruise in which 1/5-acre temporary sample plots were measured every one-eighth mile along east-west lines at 10-mile intervals. A total of 15,000 miles of line was run, and 120,000 plots were measured. This extensive sample provided adequate figures for States and groups of counties but did not provide satisfactory information for individual counties.

Past, Present, and Future

In 1946 the second Forest Survey was begun. By combining efforts with public and many large private landowners, the Survey obtained forest statistics on areas and volumes and in some cases on growth, timber cutting, and allowable cut, by counties. Aerial photos were used to increase accuracy at a small cost.

A 40-acre-block mapping procedure was used in heavily forested areas; a dot sample in lightly forested areas. Both permanent and temporary 1/5-acre plots were established using an optimum sampling scheme. The resulting statistics showed the forest situation in enough detail to be useful for helping to locate new industrial plants.

This detailed inventory took almost 12 years. Of the 71 local reports planned for publication by State cooperators, all those for Minnesota (19) have already appeared, as have 14 out of 15 for Michigan and 33 out of 37 for Wisconsin. In addition, several area reports and a number of Technical Notes and Station Papers have been published by the Forest



Crew tallying Forest Survey plot in a well-stocked northern hardwood poletimber stand in Michigan.

Service. State reports for Michigan and Wisconsin will also be prepared by the Station, as was the recently published "Minnesota's Forest Resources." The statistics presented in these reports are being used extensively by industry and are stimulating establishment and expansion of wood-using plants. They also provided the Lake States information for the Timber Resource Review which analyzed the Nation's timber resources in 1953.

In the future the Forest Service anticipates a 10-year cycle of Forest Survey in the Lake States. The third survey of Minnesota is in prospect, with some preliminary planning now under way. The Forest Survey staff at the Station is responsible for resource appraisals in 13 States of the Lake, Central, and Plains areas. While some States will have a cycle longer than 10 years, no more than 2 years can be spent in any State. Very careful planning and maximum use of the efforts of cooperating land managers will be necessary if a detailed inventory is to be accomplished during the time scheduled. The Station expects to hold the line on costs through improved techniques and to work for the standardization of figures necessary to make forest resource figures additive across the region.

New Survey Plan For Missouri

The general form of the next round of Forest Survey is illustrated by the plan for the reinventory of Missouri which was begun in 1958. Aerial-photo sampling provides accurate estimates of forest areas by counties at small cost and improves the accuracy of forest area statistics for types, stand sizes, and stocking classes. Samples of each aerial-photo classification are examined on the ground to provide corrections. Photo dots cover the entire State at about 1/2-mile intervals. Ground plots are established at about 3.6-mile intervals under a proportional sampling scheme. Every plot is carefully referenced to provide for relocation, and every tree

on each plot is recorded separately to provide for growth and mortality information at the next remeasurement. Variable plot sizes are used, the plot radius being approximately 4 feet larger for each increase of 2 inches in tree diameter. This provides an efficient sample for each tree size, while usually limiting the tally to about 15 trees per plot.

Greater emphasis is placed on classification of tree and stand condition and ownership so that the condition of the forest and its relation to ownership will be more clearly indicated.

New machine-calculation programs will be used to speed the publication of results. Reports will give individual county statistics on areas and volume for many of the heavily timbered counties. The State report will deal more with trends in forest conditions as derived from comparisons between present and earlier estimates.

While this is a pattern likely to be followed in the Central States, some changes will be necessary in the Lake States. Where large areas of public or private forests are inventoried by owners who will make their data available to Forest Survey, the regional plan will be altered to take advantage of their assistance.

During 1958 the new procedure was "shaken down" in Progress in 1958 Missouri, crews were trained, and the eastern Ozarks area was inventoried. The Missouri Conservation Department and the Moss Tie Company assisted Central and Lake States Station personnel with this work. Large areas were also covered by management plan surveys in the Shawnee and Missouri National Forests. Data from these inventories will be combined with the Station's data taken on private lands.

In addition, considerable progress was made by the Station and its co-operators in reporting and publishing results for other States. "Minnesota's Forest Resources" was published by the U. S. Department of Agriculture. The Iowa timber resources report was completed and is being edited. First drafts for the Nebraska and Michigan State reports were written. The last local reports for Michigan were prepared, and all but the southeastern block in the Lower Peninsula were published. Six Technical Notes were released and several others prepared.

The Wisconsin Forest Inventory was completed during 1958. The Conservation Department, with assistance from the Station, published 3 local reports and 1 summary covering the 32 northern counties.

The annual canvass of pulpwood receipts at Lake States mills was made and reported in a Technical Note. In addition, the Station prepared timber-cut chapters for several county Forest Survey reports published by the Wisconsin and Michigan Conservation Departments. Plans were prepared for the timber-cut studies to be made in Missouri in 1959.

Special Surveys and Studies on Survey Techniques

In addition to the regular timber resource work, some special survey studies were conducted in 1958. These included: A survey of forest plantations in northern Lower Michigan, an estimate of Christmas tree cutting in Wisconsin, two studies to help estimate timber cutting from stump examinations, an exploratory timber cut survey in Minnesota, and improvements in instruments used with aerial photos.

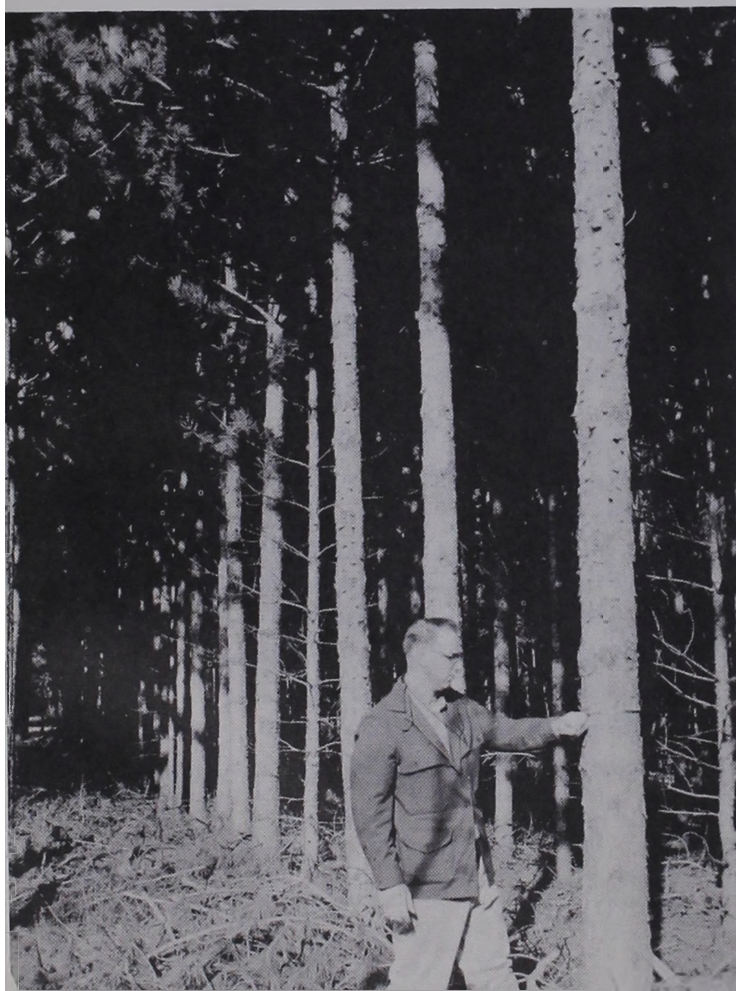
Analysis of Michigan Plantation Survey Nearing Completion

The fieldwork for the survey of forest plantations in northern Lower Michigan was done cooperatively by the Station, the Lower Michigan National Forest, the Michigan Department of Conservation, and Consumers Power Company. In 1957 and early 1958, 3,000 plots were measured, and the data are now partially analyzed. Shipping records indicate that in the last 50 years about 660,000 acres were planted to conifers in northern Lower Michigan. "Established" forest plantations were found to total 516,900 acres, reflecting losses both before and after planting. Nearly 40 percent of the forest plantings have significant native tree overstories, indicating that one of the management problems is releasing overtopped plantings.

Current planting rates in northern Lower Michigan are high, with about 26,000 acres being planted annually. On public lands tree planting is somewhat below the peaks hit during the depression, but on private holdings the rate is still climbing.

More than 27,000 acres have reached medium- and well-stocked poletimber size, and many of these should have thinnings during the next decade to maintain good growth. Throughout the area volume in trees over 5 inches d.b.h. is increasing rapidly and may well triple in the next 10 years.

A rapidly growing 25-year-old red pine stand. Plantations of poletimber size total 27,000 acres in northern Lower Michigan.

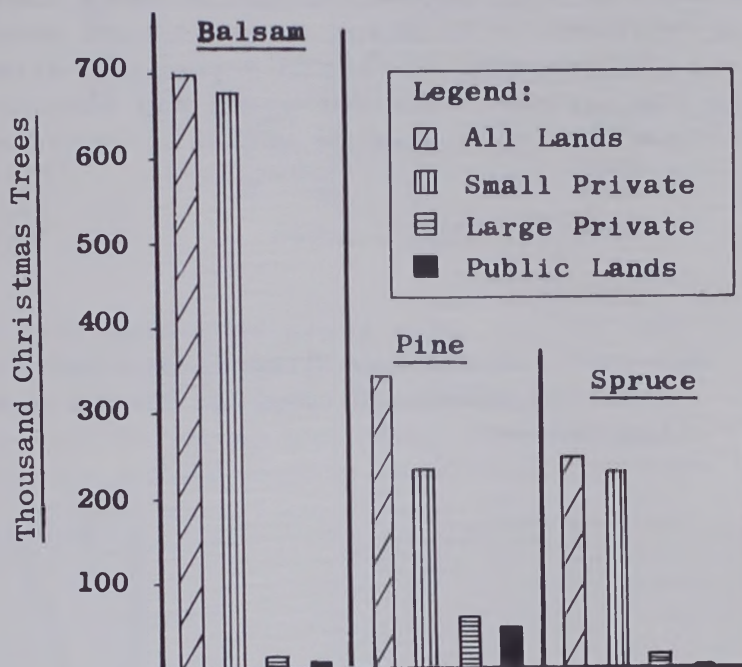


Additional information about volume, basal area, site, height and diameter growth, past treatment, and damage is being analyzed and will be reported in a Station Paper next year.

A survey to determine the approximate size of Wisconsin's 1957 Christmas tree harvest was completed in 1958. The survey was spearheaded by the Wisconsin Christmas Tree Producers Association, with the Lake States Station taking part in the compilation and interpretative phases of the survey. Licensed Christmas tree dealers, Association members, large private landowners, and public agencies with land holdings were canvassed by the Association with an overall response of about 45 percent.

Wisconsin Christmas Tree Harvest Estimated

Wisconsin Christmas-tree
cut by species and
ownership, 1957.



A Technical Note on the results of this survey has been prepared for publication in early 1959. Almost 1-1/3 million trees were harvested, most of them from small private holdings. Surprisingly, about 30 percent were plantation-grown trees. The largest cuts were registered in Lincoln, Oneida, and Douglas Counties.

Not more than a decade ago pine was rarely sold as a Christmas tree in Wisconsin. Currently pine ranks second only to balsam, which is the leading Christmas tree species in Wisconsin.

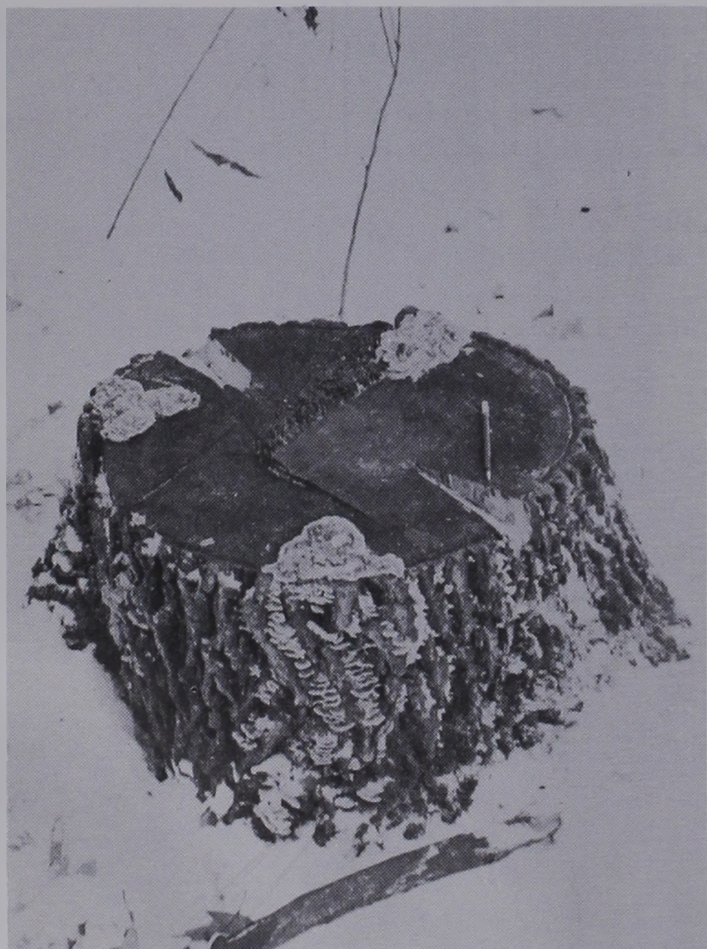


The Use of Stumps
in Measuring Volume
of Cut Timber

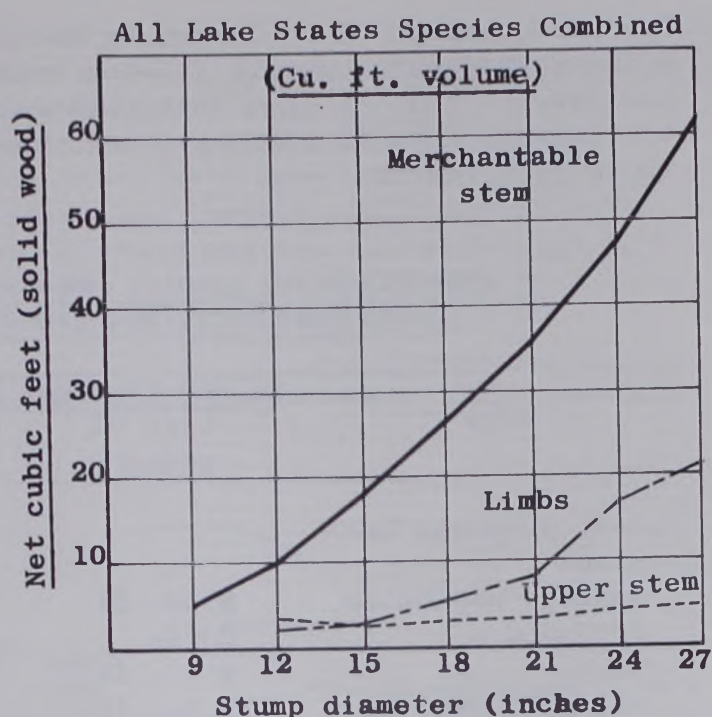
Up to now timber cut has been apportioned by species and product, using industry cutting records. In the future we will also separate timber cut by ownership, tree-size class, timber type, stand size, and other characteristics for given areas. To do this, field crews will gather cutting information from the inventory plots as they collect growth and volume data. They will measure and record by size and species the stumps of trees cut within a 3-year period.

To prepare guidelines for collecting this information, a study was conducted to determine the age of stumps for Lake States conditions. Through the summer and fall of 1958, measurements were taken on 140 recently cutover plots. Although final analysis has not been completed, several differentiating criteria have been noted, the most prominent being the contrast of 3- and 4-year-old stumps by the degree of rot found in the sapwood. Further study may disclose variations in slash deterioration that will also be useful in aging stumps.

A 3-year-old red oak stump (left) and a 4-year-old stump (right). Note the increased coverage of the older stump by fungus fruiting bodies.



Average volume of trees removed
in logging related to stump
diameter.



In the second stump study 15 widely scattered areas were visited and nearly 500 felled trees were measured on logging operations to provide information for converting stumps to net volumes of standing timber. Tables, prepared for each major species group and stump size, show the average tree volumes removed at integrated logging operations and thus eliminate some of the error introduced when local volume tables are used to convert stumps to standing timber.

Up-to-date timber-cut figures for the more important timber-producing counties are frequently sought by local forest industries and public forestry agencies in each of the three Lake States.

To meet these growing demands, the Station in cooperation with the Office of Iron Range Resources and Rehabilitation has been doing some exploratory work in an attempt to devise a "quickie" type of survey that will give reasonable timber-cut estimates for individual counties or other small local areas.

New Methods Explored
to Get Up-to-Date
Timber-Cut Data

With the Station acting in an advisory capacity, a new timber-cut survey was tried by the OIRR&R in Hubbard County, Minn. The method was aimed at obtaining timber-cut estimates through ownership contacts. All public and large industrial timberland owners in the county, 25 percent of the small industrial owners, and 1½ percent of the farmers and other rural nonfarm residents owning timber were canvassed. From the cutting records and interviews, estimates were computed showing the volume of timber removed by species and product for each ownership class.

For a comparison of estimates by two methods, all sawmills and other primary wood-using plants drawing wood from the study area were also canvassed. Results show that timber-cut figures obtained through industry canvass were 12 percent below those obtained through ownership contacts (see table).

A comparison of results obtained from two timber-cut
survey methods, Hubbard County, Minn., 1957

Item	:Volume recorded by each survey method:				Difference (percent)
	: Unit of	: Ownership	: Industry	:	
	: measure	: survey	: survey	:	
Forest products har- vested:					
Sawlogs and bolts	M bd.-ft.	5,400	5,200		-4
Pulpwood	Cords	46,000	41,000		-11
Other	M cu. ft.	1,440	1,674		+16
All products	M cu. ft.	5,919	5,730		-3
Timber cut on com- mercial forest land					
	M cu. ft.	5,396	4,736		-12

From these studies it was concluded that in areas where public and large industrial holdings represent more than one-third of the commercial forest land area a 2-percent minimum sampling intensity is recommended for the farm owner class. In areas where farm woodlands comprise more than two-thirds of the commercial acreage, a 4-percent minimum sampling intensity is recommended.

Improved Techniques
in Studying
Aerial Photos

Two instruments for use with aerial photos were developed. One provided for rapid and accurate orientation of a dot-grid transparency over an aerial photo. The second provided for more effective use of a parallax bar under 4-power magnification of a Zeiss Mirror Stereoscope with the aid of a drafting arm to hold aerial photos in proper alignment. Two reticles were developed for more exact measurement of stand density.

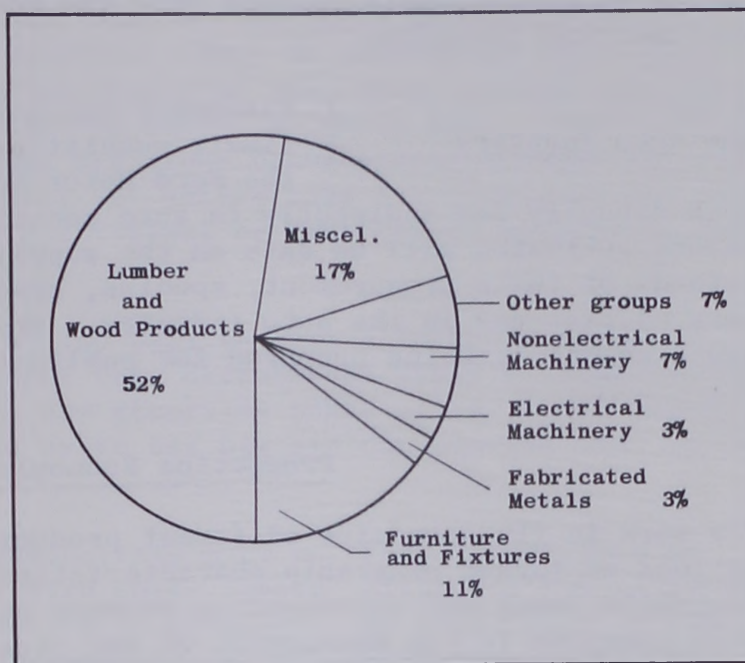
Marketing Studies

Requests for market information about forest products are varied and frequent. For this reason opportunities to develop market information through research should be directly related to needs. This consideration has been a primary Station objective in the limited number of market investigations it has undertaken. Three market studies are now in progress.

Questions on how much and what kinds of lumber are used in the Twin Cities, what it is used for, and where it comes from are raised from time to time by a variety of interested parties and for a variety of purposes. Two surveys in as many years have been made as a start in acquiring such information. Both have been largely exploratory, seeking primarily to outline methods which would provide reliable answers to these and other questions at moderate cost. Both were made in cooperation with the Minnesota Department of Conservation.

Survey of Lumber Use in Twin Cities Manufacturing

Volume of lumber used by various manufacturing industry groups in the Twin Cities.



The first survey estimated the volume of lumber used by 7 of the 20 manufacturing industry groups within the city limits of St. Paul and Minneapolis during 1956. Results have been reported in a series of eight Station Technical Notes. The second survey was improved by correcting several shortcomings discovered in the first design and was enlarged to estimate lumber volume used by all 20 manufacturing industry groups during 1957. These survey data have been analyzed. The report now being written will show the estimated 60,200,000 board feet of lumber purchased for industrial use during 1957 by purchase source, species, use, grade, moisture content, and thickness.

The growing use of charcoal as a luxury item for both indoor and outdoor cooking leads naturally to consideration of markets by those involved in its manufacture, merchandising, and selling. To learn some of the facts associated with the market for packaged charcoal, a sample of retail stores in Wisconsin was visited and their managers and owners interviewed regarding the sale of

New Data Collected on Charcoal Marketing in Wisconsin

charcoal during 1956 and 1957. Analysis of these data should provide useful information on such items as total quantity of packaged charcoal purchased, package-size availability and movement, importance of urban community size on sales, seasonal sales variation, and market channels.

Despite highly seasonal limitations of domestic demand, the total volume of charcoal used for domestic purposes has exceeded industrial uses for some years. This major shift in user pattern was discussed in Station Paper 46, released in June 1957. Some features of the evolving retail charcoal marketing structure which were still indistinct at that time should be more clearly evident when the more recent study data have been analyzed and reported.

Wood Use
in the Auto Industry

Fieldwork has been completed on a study to estimate quantities of lumber and fiber used by the Ford Motor Company in the Detroit area both directly and indirectly in auto construction. Accompanying these volume estimates will be data on the supply sources of wood materials, methods of their procurement, species, grades and sizes used, and a history of past use in the auto industry. These data have been analyzed and a report is being prepared for publication.

Production Economics

New work in the economics of forest production was centered on investigations of forest ownership characteristics and a forest tax study. Meanwhile, work was continued on methods to determine the input-output relationships in the management of red pine in Minnesota. As background information for this project, the feasibility of release cuttings in pine stands and the marking costs of black spruce were studied. These investigations take advantage of data on hand from experimental forests. Results will be published in 1959.

Ownership Characteristics
as Related
to Forestry Practices

In view of the anticipated large increase in future demand for wood products as shown by the Timber Resource Review and the fact that relatively unproductive small forest ownerships of less than 5,000 acres make up more than 75 percent of the commercial forest land east of the Great Plains, the Forest Service instituted a number of ownership surveys in the eastern States.

The general aim of these studies is to build a fund of knowledge about the characteristics of small private forest owners and their attitudes toward forestry that will aid in selecting the best means for encouraging them to improve their forestry practices.

As the Lake States Station's part in this program, two studies are currently being undertaken. One, comprising 13 counties in central Wisconsin,

is nearing completion while the other, involving the lower half of southern Michigan, has just started.

A preliminary analysis of the Wisconsin data reveals that most small private owners do not take part in programs designed to promote forestry nor do they generally practice forestry of any sort. Apparently many of the reasons for this apathy toward forestry are concerned with small acreages, low timber values, and low per-acre volumes. The average woodland acreage for owners contacted was about 52 acres.

Over half the owners contacted indicated that the primary use of their woodlands is growing timber, and many are actively utilizing forest land for home-use products. For instance, about 85 percent of the farmers (who form the majority of forest owners in this area) pointed out that home-use products were important to them. Slightly more farmers are interested in growing timber than are other occupational groups. Yet the vast majority of owners not only let nature take its course in the woodlands, but they often follow inefficient or destructive methods of utilization.

Over 90 percent of the owners also fail to seek a forester's advice about forest practices. Some of this disinterest appears to stem from the fact that although owners are generally aware of the local forester's existence, they are uncertain as to how his aid can benefit them or what his functions are.

The study in Michigan will concentrate more on owners' reactions to assistance programs and will also cover owners' attitudes toward forest yield taxes and the profitability of forestry. An evaluation of cutting practices will be made and compared to various owner characteristics. Included in this study will be an estimation of the impact of urbanization on forest holdings.

Interest in forest taxation in the Lake States is increasing. In Minnesota the passage of the Minnesota Tree Growth Tax Law opens a new approach in the Lake States for taxing forest land. Michigan has recently revised its forest yield tax law (Pearson Act). In Wisconsin proposals have been made for revising the Forest Crop Law. The pressures of rising governmental and educational costs are causing local taxing authorities to take a new look at the special forest tax laws.

Forest Taxation
and Tax Load
on Forest Incomes

The general property tax, in theory, taxes property according to the annual income that it produces. In forestry, annual incomes are stored in the standing tree in the maturing forest year after year. The general property tax, as it is usually applied to forest stands, taxes not only last year's income but the incomes of previous years as well.

How will an increase in forest taxation affect the tax load on forest incomes? An estimate of this effect in central and northeast Wisconsin

will be reported by the Station in 1959. The report is the result of a study begun in February 1958 in cooperation with the Wisconsin Conservation Commission.

The study highlights the differences in tax per dollar of income under Wisconsin's Forest Crop Law and general property tax laws for lands of varying productivity and value. Furthermore, it shows that forest land as a whole is assessed (and thus taxed) at a higher percent of market value than are other classes of general property. It also presents some discussion of the working of the law as seen by local officials in the counties.

Cooperative Work in Forest Economics

The Station is participating in a number of studies being pursued by co-operators, mainly universities. Two of these are carried on by the University of Minnesota: one on farm lumber consumption and one on the use of hardwood for containers. A report on the latter is awaiting publication, while the analysis and preliminary writing have been done for the farm lumber consumption project. This study has provided data for several possible reports, among them a description of the new methods of survey and analysis employed.

An attempt to estimate the demand for hardwood lumber for furniture is being made by the University of Michigan with assistance from the Station. This work involves correlation of hardwood furniture production with various economic statistics to arrive at a satisfactory method for projecting future use of hardwoods for furniture. Such studies are necessary to strengthen estimates of future demand for timber in national summaries such as the Timber Resource Review. The study of farm lumber consumption also serves this purpose.

Forest Management

R. D. McCulley, Division Chief

To discover better ways of establishing, growing, tending, measuring, and harvesting forest stands are the objectives of forest management research. Included, in addition to applied silvicultural studies, is basic research on the environmental (silvics) and hereditary (genetics) factors governing tree behavior and development.

Necessarily, much of this research is done within local problem areas. The laboratory and other facilities being developed at several of these points will permit more emphasis on fundamental research. This is essential to continued progress as the management of forest land becomes more intensive. These facilities will need periodic strengthening in the future to maintain proper program balance.

Development of currently useful guides to successful practice continues to be a high-priority job for forest management research. In particular, we must know how to reproduce timber stands if forest production is to be sustained or improved. Yield information also is required for intelligent choice between management alternatives. Furthermore, specific nursery, planting, release, thinning, pruning, and other practices need to be made more efficient, thus increasing the potential for production of good-quality timber. All this must be done with proper regard for effects on other uses of the forest such as recreation, wildlife, and production of water.

During 1958 some studies concerning most of the aspects of forest management were carried on at the Station. Brief reports on some of these studies follow.

Tree Responses to Environment

How trees respond to various environmental factors governs the success of silvicultural practices and provides clues to the most beneficial practices. Current studies concern influences of soil, climate, and other environmental factors.

A step in broad research on soil-site relationship is a study to determine the effect of soil characteristics on the growth of green ash (*Fraxinus pennsylvanica*).

This study was begun last year and continued in 1958.

The expanding program of field shelterbelt planting, using 1- to 3-row belts, makes it increasingly important that the species used will provide the best continuity of effective wind barrier for the maximum

Effect of Soil
Characteristics
on Tree Growth



Measuring green ash in Plains shelterbelt to assess the effect of soil texture, soil depth, and other characteristics on the growth of green ash.

number of years. Information gained on the growth of green ash, a species planted over a wide range of soil and climatic conditions, will be correlated with that of other species, enabling the tree planter to select the right species or combination of species to produce the best windbreak on each planting site.

Aspect Phenology of Sugar Maple Seedlings in the Northern Hardwood Type

Height measurements of understory sugar maple seedlings on the Upper Peninsula Experimental Forest at Dukes, Mich., during 1957 and 1958 show that approximately 90 percent of the height growth had occurred by June 1, at which time the leaf development of the overstory was about one-half complete. The growth rate decreased during the month of June. By July 1, when the overstory was completely developed, nearly 99 percent of the stem elongation had been completed. Some seedlings continued to grow at reduced rates until the first week of September.

Other phenological studies at Dukes show that sugar maple and yellow birch begin height growth about the same time, but birch stops growth 3 weeks earlier. Eastern hemlock begins stem elongation 2 weeks after sugar maple, but continues it for almost a month later.

Natural Regeneration

Current research is shedding some light on the effects of season and kind of cutting and of wildlife species on the reproduction of forest stands.

Yellow birch has proved a difficult species to reproduce in the northern hardwood type. Recently the Upper Peninsula field unit, therefore, has established a study to test

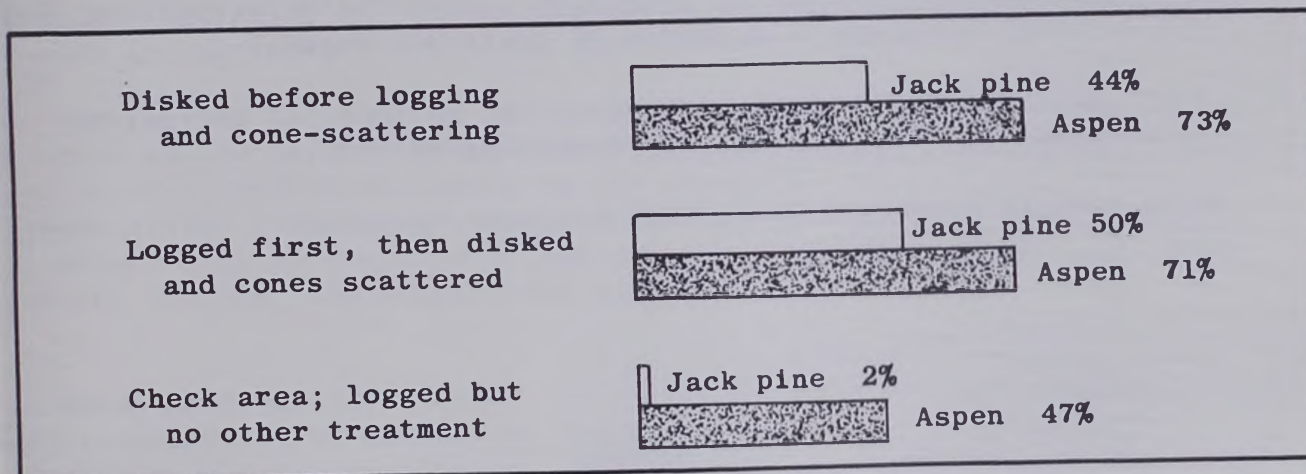
Seedbed Conditions
Best Suited for
Yellow Birch Reproduction

the effects of season of logging, stocking, and seedbed condition on the establishment and development of yellow birch reproduction. Results after 1 year show that disturbed (favorable) seedbeds created by fall and summer logging cover 3 to 3½ times the area of similar seedbeds on the winter-cut units when the heavy snow blanket prevents much of the desired surface disturbance. On an overall basis, however, even the fall and summer logging created desirable seedbeds on only 14 percent and 19 percent respectively of the cutting areas.

In an effort to reduce the cost of restocking cutover lands on the Superior National Forest in northeastern Minnesota, the Station is co-operating with the Forest on a comparative study of measures used to encourage regeneration of jack pine and other conifers.

Methods for Encouraging
Conifer Regeneration

One year after cones were scattered on disked plots, stocking of jack pine seedlings that are free to grow averaged almost 50 percent compared to only 2 percent where no treatment was given (see chart). The treatment, however, had also stimulated the production of aspen suckers, which averaged 72 percent stocking on the treated plots and only 47 percent on the check.



Percent of quadrats stocked with jack pine and aspen 1 year after treatment. This test is part of a study of measures to encourage regeneration of cutover land.

Red Pine Seed
Production in Different
Kinds of Stands

In the fall of 1957, just before dispersal of the bumper 1957 seed crop began, 3.3x3.3-foot seedtraps were set out under 90-year-old red pine stands on the Cutfoot Experimental Forest

in north central Minnesota, with 30 in a managed stand and 6 in an unmanaged stand. In addition, 8 traps were installed in a 50-year-old managed stand.

Seed was collected from each of the traps every 10 to 30 days from Oct. 10, 1957, until Sept. 29, 1958. The results of the first year's catch (some seed was still being trapped at the last examination) were as follows:

<u>Type of stand</u>	<u>Seedfall per acre</u>	
	<u>Total</u>	<u>Viable</u>
90-year, managed	1,062,000	908,000
90-year, unmanaged	453,000	418,000
50-year, managed	100,000	92,000

Judging from these results, a red pine stand of intermediate age is a surprisingly poor seed producer. Remarkable also is the great difference in production between the managed and unmanaged stands of like age.

Natural Regeneration Under
Various Cutting Systems
in Swamp Black Spruce

Regeneration success of black spruce being studied under six cutting systems in northern Minnesota indicated the following, 4 to 6 years after cutting:

1. The stocking of black spruce seedlings successfully established after cutting increases with degree of overstory removal.
2. Even-aged management, employing clear-cut patches and strips, or shelterwood cutting, is the most promising method.
3. More time is needed to fully test all-aged management, but it seems



Clear cutting swamp black spruce in patches or strips shows promise as a method of encouraging regeneration. Slash should be removed to permit even distribution of regeneration. In area shown, slash was windrowed in the center of strip and burned.

certain that the basal area stocking of mature timber must be reduced below the 76 to 87 square feet per acre originally tried.

4. Slash concentrations in the clear-cut strips and patches cause uneven distribution of regeneration and should be removed.
5. Seedbed conditions greatly influence the distribution of new reproduction (see Technical Note 504).
6. Advance growth must be abundant and well distributed to be considered of much importance in restocking the area.

In cooperation with the Wisconsin Conservation Department the Station surveyed a cutting methods study in second-growth northern hardwoods on the Argonne Experimental Forest and found that deer

Deer Browse Surveys
in Northern Hardwoods
and Aspen-Balsam Fir

browsing occurred on 77 percent of the sample quadrats which had reproduction 2 to 7 feet tall. Browsing was least on the clear-cut blocks, strip clear cuttings, and 8-inch-stump-diameter-limit cuttings, although these areas had the highest percentage of quadrats stocked with reproduction between 2 and 7 feet tall. More important from a silvicultural viewpoint, however, is that 89 to 100 percent of plots stocked with stems from 2 to 7 feet tall were browsed on the areas that received a light partial cut, approximating recommended silvicultural practices for the type.

In an aspen-balsam fir cutting area, preliminary observations indicated that red maple and aspen, which compete with the more valuable conifers for growing space, are being eliminated by snowshoe hare and deer while balsam fir and spruce are being browsed very lightly.

An interesting development in oak regeneration studies on the Hardies Creek Timber Harvest Forest in west central Wisconsin is the change in

Factors Affecting
Oak Regeneration

the stocking of northern red oak seedlings on transects scarified with an Athens disk as compared to the untreated checks. After 1, 2, and 7 growing seasons, the comparative data are:

Duration of tests (years)	Number of trees per acre		Average seedling height (inches)	
	Disked plots	Undisked plots	Disked plots	Undisked plots
1 (1952)	2,390	720	1/	1/
2 (1953)	2,930	930	4.2	6.3
7 (1958)	2,762	2,500	6.9	7.3

1/ Not measured.

The stocking of northern red oak seedlings has more than doubled on the untreated checks, while that on the disked transects has changed only slightly. Why this is so will be the objective of additional study.

In this same area 5- to 6-year plot results indicate that the factors affecting mortality and growth rates of juvenile oak most adversely are, in order of decreasing importance: (1) Excessive competition from woody shrubs and herbaceous vegetation, (2) rabbits, (3) mice, (4) deer, and (5) insects and diseases.

Stand Improvement

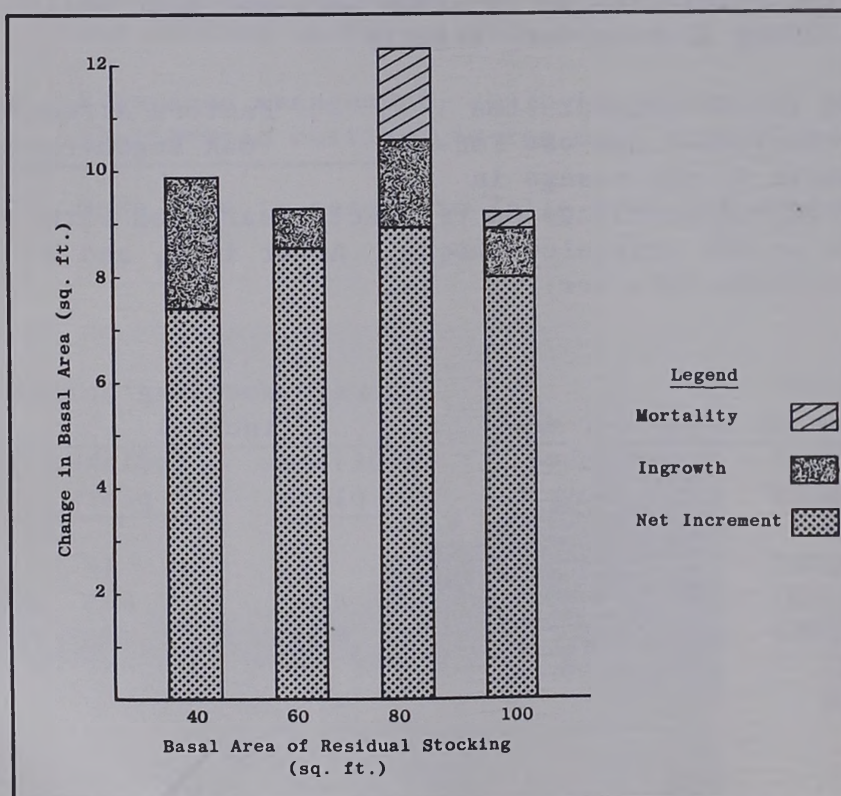
Several studies have shed light on problems of improving developing stands through cultural practices such as thinning, release, or pruning.

Optimum Stocking Levels in Second-Growth Northern Hardwoods

During the spring of 1954 a stocking level study of a second-growth hardwood stand was initiated in Upper Michigan in cooperation with the Newport Land Company and the Oliver Iron Mining

Division of the United States Steel Corporation. The primary objective of the study is to determine the optimum residual stocking levels for second-growth northern hardwood stands during conversion to management by the selection system.

Preliminary results, after a 5-year growing period, support the general conclusion that a residual stocking level of 80 square feet of basal area per acre is near the optimum for growth and for development of the desired stand structure (see chart).



Five-year change in stocking on second-growth northern hardwood stand thinned to different stocking levels; per acre.

The stand with 80 square feet of basal area also appears best for retarding sprout development while fostering adequate seedling reproduction. A comparable study in older stands indicated that gross basal area increment was better in stands with a stocking of 70 square feet of basal area than in those stocked at 50- or 90-square-foot rates. This corroborated earlier plot results.

A long-term study of noncommercial thinning in second-growth northern hardwood has brought to light some very interesting facts about growth and clear-length development. The study involves a stand that was thinned when 11 years old. All trees competing with selected crop trees for a radius of $2\frac{1}{2}$ and 5 feet around the crop trees were cut. When the stand was 20 years old these radii were increased to 5 and 7 feet respectively.

Pruning and Noncommercial
Thinning Effects in
Second-Growth Northern Hardwood

Yellow birch shows good response to artificial pruning. Left, tree before pruning; the sharp-angled lower branches persist for many years if not removed artificially. Right, same tree after pruning; clear bole length is now 20 feet.



At 30 years of age the most heavily thinned plots had 1.4 thousand board-feet per acre compared to 0.8 thousand board-feet on the unthinned plots. Clear-length development, however, was limited on the heavily thinned plots. Of the sugar maple crop trees 5 inches d.b.h. and over in the heavily thinned plots, 42 percent were forked below $1\frac{1}{2}$ logs. Only 25 percent were forked below $1\frac{1}{2}$ logs on the unthinned plots. Of the elm crop trees, 66 percent were forked below $1\frac{1}{2}$ logs on the more heavily thinned plots compared to 46 percent on the unthinned plots.

That this situation can be partially corrected by pruning is demonstrated by the plots that were thinned as outlined above and also pruned. Pruned sugar maple on the heavily thinned plot averaged 2 feet more clear length than did unpruned trees. Pruned American elm averaged up to 4 feet more clear length regardless of the thinning treatment. A related study in Upper Michigan also gave favorable results from pruning yellow birch.

Aerial Spraying to Control Aspen and Scrub Oak

Large areas of low-value aspen and scrub oak stands need control to release conifer reproduction or plantations or to prepare the areas for economical planting. Aerial spraying is the most promising method. Although aspen has proved somewhat difficult to control beyond the sucker stage, studies in northeastern Minnesota have shown that practically complete kill of mature aspen can be obtained with 3 pounds of 2,4-D in 4 gallons of fuel oil per acre applied in late August. On smaller aspen in Lower Michigan only 2 pounds of 2,4-D in oil is necessary. In both areas the treatment was more effective and cheaper than the use of 2,4,5-T or a mixture of 2,4-D and 2,4,5-T.

In Lower Michigan also, results 2 years after treatment showed that $\frac{1}{2}$ pound of 2,4,5-T in an oil-water carrier was as effective on oak as 1 pound of brushkiller in a similar carrier, and that $\frac{1}{4}$ pound of 2,4,5-T in diesel oil carrier was more effective on oak than either $\frac{1}{2}$ pound of 2,4,5-T or 1 pound of brushkiller in oil-water carrier.

Control of Hardwoods by Amine Salt of 2,4-D in Frill Girdles

Tests started in 1954 using small volumes of concentrated herbicides have shown that the amine salt of 2,4-D is less bulky and slightly more effective in small quantities than 2,4,5-T esters for controlling hardwoods by chemical frill girdling.

With the amine salt of 2,4-D the herbicide is diluted in an equal volume of water (50 percent solution by volume) and added to the frill girdle at the rate of 1 milliliter per inch of diameter or 3 inches of circumference. At this rate of application 1 gallon of solution will treat about 4,000 inches of diameter or approximately 4 acres. This is about four times the area that a gallon of 2,4,5-T ester in oil will treat.

Harvest Cuttings

How mature forest stands are harvested governs not only the kind, quantity, and quality of products that can be obtained but also the species, density, distribution, and adequacy of reproduction that will develop. Present studies relate to cutting methods, growth, yield, mortality, and logging injury.

Results 5 years after cutting in Upper Michigan indicate that heavy cutting on small areas may provide the best conditions for the establishment of a new coniferous stand in the mixed coniferous swamp type.

Cutting Mixed Coniferous Swamps to Obtain a New Conifer Stand

In a light-selection and a diameter-limit cutting, the conifer seedlings are in a less favorable position than they were 5 years ago. A shelter-wood cutting has slightly improved the coniferous seedlings' advantage over the last 5 years, but clear cutting in small blocks and narrow strips has been the most effective.

The area with advanced reproduction was reduced by all types of cutting as a result of skidding and smothering by slash. The loss was directly related to the intensity of the cut. The establishment of new reproduction, however, has increased the stocking in all methods of cutting with the most gains in the heavier ones.

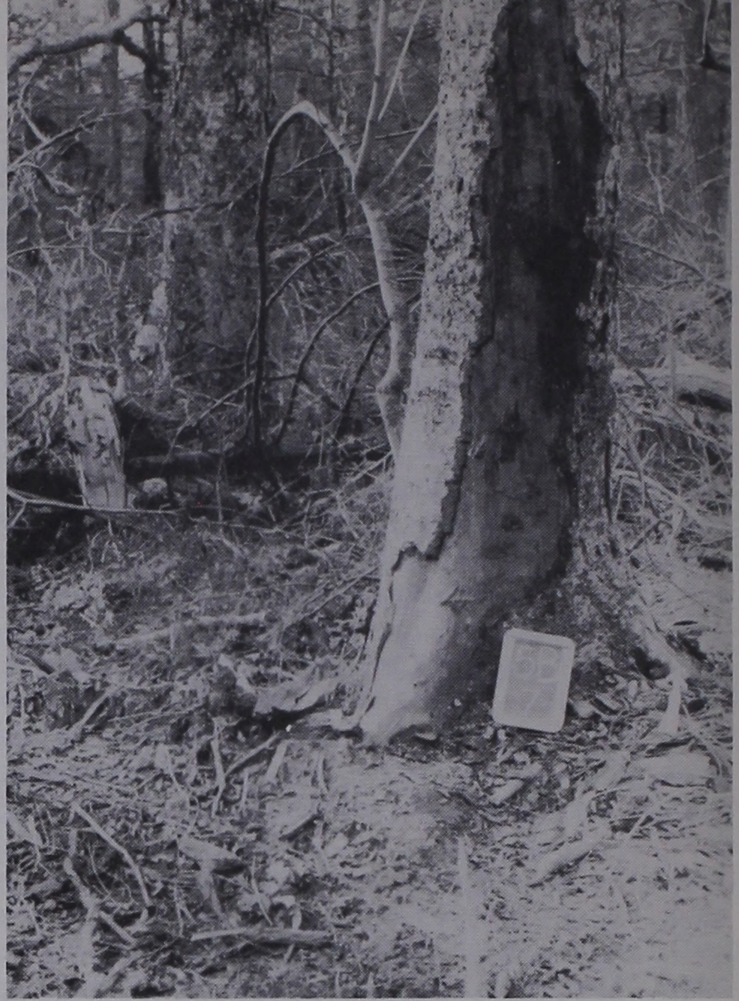
The loss of reproduction caused by logging slash, which was most widely distributed on the heavier cuttings, has been largely overcome after 5 years.

Blowdown in the residual stand was largely restricted to trees in the lower crown classes. Considering all the cutting methods, only two trees per acre or 5.5 percent were lost from the uppermost crown canopy compared with 15 trees per acre or 7.5 percent from the lower crown classes.

A study of the effects of logging injury on sugar maple and yellow birch, in cooperation with the Ahonen Lumber Company in Upper Michigan, shows that the size of many injuries has increased after 2 growing seasons. On 90 percent of the thin-barked injured yellow birch and 24 percent of the thicker barked sugar maple trees the wounds have enlarged during the 2 years since injury. Probably this is due to bruising of the bark surrounding the immediate area of the wound.

Progress of Healing in Northern Hardwood Logging Wounds

Besides the increase in size of wound, many trees showed no signs of healing after 2 growing seasons. Callus formation was visible on 59 percent of the yellow birch and 95 percent of the sugar maple. Wounds on 79 percent of the sugar maple trees were classified as healing fast compared to only 7 percent of the yellow birch.



Two growing seasons after injury, both of these logging wounds are larger. However, the vigor of the tree with the large wound has declined considerably, while the tree with the small wound has remained vigorous.

Growth, Yield, and Mortality of Spruce in Relation to Cutting Practices

Remeasurement of permanent plots in northern Minnesota 5 seasons after logging has provided tentative information on the response of black spruce to cutting systems. Some

important trends include:

1. Wind was the most common single cause of mortality in all systems, but such damage has been minor on clear-cut patches and strips and in the lighter partial cuttings.
2. Wind-caused mortality increases with intensity of partial cutting, with stand age, and with site quality.
3. Serious wind losses occurred only in shelterwood cuttings in old timber on good sites. Much of the mortality was due to stem breakage associated with butt rots.

In a test of the response of black spruce to cutting systems, the only stand that suffered serious wind damage was a shelterwood cutting in tall, old spruce.



4. For stands over 100 years of age, net pulpwood yields were not substantially different in uncut timber than in stands given light partial cuttings. Thus, there may be no advantage in thinning these older stands. Results for younger stands are inconclusive so far.

Genetics

Improvement of the forest through manipulation of environmental conditions is a major objective of silvicultural research. Improvement can be effected also through increasing the genetic quality of our forests. The latter is the purpose of research being conducted by the Station at the Northern Institute of Forest Genetics in northeastern Wisconsin and elsewhere in the region.

The establishment of the Northern Institute of Forest Genetics almost 2 years ago has permitted the Station to greatly expand its tree improvement program. Some of the studies now under way at the Institute are mentioned briefly here.

Progress at the Northern Institute of Forest Genetics

During 1958 white spruce seed from 29 localities representing the botanical range of the species and eastern white pine seed of 17 sources were sowed in the nursery. At the end of the first growing season the white spruce seedlings showed considerable variation both in total amount of growth above the cotyledons and in the time of the termination of growth as related to origin. The white pine seedlings showed much less variation between sources.

Indices for the more important Lake States species are badly needed in order to put the selection of plus trees on a firmer foundation. To this

end a study of the variation between individual white spruce trees has been started. Initially we are concentrating on wood quality, but eventually other commercially important characteristics will be considered.

Approximately 400 slides of the initial stages of the flower formation in white spruce have been prepared for scrutiny under the microscope to determine the earliest possible time during the season at which flower primordia can be distinguished.

A considerable effort has been spent during the past season in an attempt to get an intensive plus-tree selection program under way. Several training sessions have been held with Experiment Station, national forest, and State field personnel. Plus-tree characteristics of the most important conifers were discussed and demonstrated on prepared tours. It is hoped that such sessions will create an interest among foresters so that more potential plus trees will be reported.

Results of a study with the new growth-regulating chemical, gibberellic acid, have shown that applications of this compound to dormant buds of many of the northern hardwood species can bring about a flush of growth considerably in advance of normal growth. This information is of particular advantage to research workers who wish to force seedlings that have not received a full winter's cold exposure.

The physiology of summerwood formation in red pine is being studied by regulating the activity of the terminal meristem. Results to date indicate that seedlings maintained under long-day (18-hour) conditions will produce summerwood cells with abnormally thick walls and large lumens. When such seedlings are placed under short-day (8-hour) conditions they will revert to the production of the normal, narrow-lumened summerwood cell type. Seedlings that have been alternated from long-day to short-day to long-day conditions will produce an obvious false ring with the narrow-lumened short-day type cells lying between adjacent bands of the large-lumened long-day type cells. Similar false rings have been produced by applications of the growth hormone, indole-acetic acid, to decapitated stem tips of seedlings maintained under short-day conditions.

Second-Year Results
of the Jack Pine
Seed Source Study

In 1954 jack pine seedlings of 29 sources in the Lake States were planted in 17 localities throughout the region through the cooperation of several Federal, State, and private forestry agencies. Second-year results in the field indicated an average stocking of 94 percent and a range of 74 to 100 percent for individual sources. Total height at the end of the second year strongly reflected local site conditions. Although the pattern is different for each plantation, a few proveniences were rather consistently good and a few others were rather consistently poor. Good height growth was made by collections from Pine County, Minn., Marinette County, Wis., Manistee County, Mich., and Cass County, Minn. (in that order). Conversely, collections from Itasca County, Minn., Bayfield County, Wis., and Chippewa County, Mich., performed poorly.

To help encourage and coordinate forest tree improvement activities in the region, the Lake States Forest Tree Improvement Committee was formed in 1953. From the beginning the Station

Current Work of the
Lake States Forest Tree
Improvement Committee

representative has been the executive officer of the committee, which also has representatives of the Universities of Michigan, Wisconsin, and Minnesota; Michigan State University; the Conservation Departments of Michigan, Wisconsin, and Minnesota; the Lake States Council of Industrial Foresters; the Institute of Paper Chemistry; the Central International Conference on Forest Insects and Diseases; the North Central Region of the U. S. Forest Service; and the Forest Products Laboratory.

Currently the committee is assembling material for reports on seed certification, a comprehensive regional summary of forest tree improvement projects, and the marking and registering of selections. Planning has also been started for the Fourth Lake States Forest Tree Improvement Conference to be held in Ann Arbor, Mich., on October 6 and 7, 1959.

Nursery and Planting Studies

A substantial planting effort must be included in a progressive forestry program for the Lake States for several reasons. First is the large backlog--some 8 million acres--of nonrestocking forest land in the region. Present practices are bringing no reduction in this area. Second is the effect of increasing intensity of management which will require planting to improve the stocking of desired growing stock. Third is the need for, and expanding interest in, windbreak plantings in the northern Great Plains. All contribute to the need for more effective and economical means of establishing plantations.

A necessary basis for forest planting is the ability to produce good planting stock at reasonable cost. Advanced methods need to be put into practice as rapidly as they are developed and tested.

Conifers are a very desirable part of Plains shelterbelts. There has been considerable difficulty, however, in growing many coniferous species in Plains nurseries. Research by the

Conifer Nursery Manual
for the Plains
in First-Draft Form

Station and the experience of several nurseries have, nevertheless, indicated successful methods. The Station has therefore prepared the first-draft manuscript of a comprehensive bulletin on growing conifers in Plains nurseries. In it are summarized the results of research and the experience of the most successful nurseries known in the Plains region. This, when published, will provide a companion volume to "Nursery Practice for Trees and Shrubs Suitable for Planting on the Prairie-Plains," by H. E. Engstrom and J. H. Stoeckeler, U. S. Department of Agriculture Miscellaneous Publication 434.

Growth of Northern Conifers Under Long-Day in Florida

Greenhouse studies have shown that the onset of dormancy of many species of trees can be delayed by use of artificial lighting to extend the day length. With suitable temperature and light treatment, conifers have been kept growing throughout the year. This year a study was established to determine the response of northern species to a southern location with a very long growing season.

With the cooperation of the Southeastern Forest Experiment Station, nursery space and technical help were made available at the Olustee Experimental Forest in northern Florida. Four species were selected--white and red pines and white and black spruces--which require at least 2 years' growth, and usually more, in Lake States nurseries to produce plantable stock. One bed with these species received a 20-hour day; the other received the natural day of that latitude, which is considerably shorter than the day length under which the trees normally grow in the North. A similar experimental treatment was installed in the Hugo Sauer Nursery in northern Wisconsin to serve as a check.

The response of white pine to the long-day southern treatment was outstanding, with trees produced in 1 year equivalent to 2-year-old seedlings ordinarily produced in northern nurseries. Natural-day white pines in Florida were about twice the height of the natural-day northern-grown ones. White pine with long-day treatment in Wisconsin differed little from those with the natural-day treatment, although the long-day plants had slightly longer primary needles and many secondary ones. Red pine under both treatments in Florida were about the same height but more than twice the height of the long-day plants in Rhinelander.

Both spruces under long-day in Florida were somewhat taller than those under long-day in Rhinelander, but natural-day in Florida resulted in dwarfing the spruce so that they were considerably shorter than any of the northern stock.

Survival and vigor of the long-day plants in Florida were much better than that of the natural-day plants, but problems of fertilization and pest control remain to be solved. Observations will be continued on these plants for another growing season.

Boxelder Blight Less Severe in 1958

A blight of unknown cause has greatly reduced the planting of boxelder, a key species in windbreaks of the northern Great Plains. The blight, which causes a dwarfing and yellowing of the leaves and a marked reduction in growth, was much less severe in field plantings and in nurseries during 1958 in North Dakota than in the several previous years. In experimental plots at Bottineau new seedlings grew normally and 1-year-old boxelder trees severely affected in 1957 (average height 5.6 inches) exhibited no symptoms and attained an average height of 16.9 inches. This lends weight to the possibility that a herbicide may be a contributing cause of the damage, because herbicide spraying activities were sharply restricted in 1958.

In Upper Michigan a study of red pine plantations previously considered successful shows the present survival to be only 13 percent in the most heavily affected areas. The largest number of trees lost was among those planted between 5 and 9 years ago. Older age classes had better survival but showed the effects of heavy mortality in the past. Plantations over 10 years old averaged only 40-percent survival.

**Cause of Red Pine
Mortality in Upper
Michigan Still Unknown**

The depressed area on the left side of this young red pine stem has the outward appearance of a canker. Many cankers, however, show no outward evidence, and the symptoms are limited to necrosis of the inner bark.



A survey of the problem area showed that although dead branches were prevalent in all plantations they did not appear to be associated with survival. An unidentified canker, the next most common symptom, was found more often in areas with heavy mortality, as was the third most frequent symptom, dead tops. Although both cankers and dead tops appeared to be related to survival, the relationship between the two symptoms could not be determined.

Neither the mortality nor the symptoms on surviving trees so far can be definitely related to any environmental factors.

Planting Results
on Poor Oak Sites
Before and After Logging

Sandy soils (Grayling, Rubicon, and Plainfield sands) support over a million acres of low-quality oak stands in Lower Michigan and northern Wisconsin. These oak stands seldom produce

more than 15 to 20 cords of usable pulpwood in 65 to 75 years. One such stand on Grayling sand on the Pine River Experimental Forest in Lower Michigan was selected to study different alternatives of wood production including (1) management for pulpwood and (2) conversion to pine after clear cutting for pulpwood. Both machine and hand planting were tried before and after logging in the conversion compartments.



Should poor oak sites be planted before or after logging? This area was logged before planting and consequently required more hand planting than similar areas logged after planting.

The results of this study show that: (1) Before cutting, it was possible to plant with a light tree planter, and the planting could be concentrated in openings away from the oak trees; furthermore, very few planted pine were seriously damaged by the logging. (2) After logging, the openings are filled with slash and more pine is planted near the stumps where sprouts are likely to cause serious competition and later may suppress the pine. With heavy slash both machine and hand planting proved very difficult.

Red Pine-Jack Pine
Spacing and
Thinning Study

In the spring of 1958 the Station cooperated with the Wisconsin Conservation Department in the establishment of a Statewide planting study.

The plan calls for both red and jack pines to be planted on various sites at several spacing intervals and then to be managed in different ways. So far, 8 red pine replications have been

established at 2 locations in Jackson County and in Washburn County. The study is designed to test spacing, thinning, and some of the interrelationships between the two. The studies in red pine include 5x5-, 7x7-, 9x9-, and 11x11-foot spacings. For jack pine these intervals will be reduced by 1 foot.

Forest Fire Research

Loyd LaMois, Project Leader

The early record of the Lake States in burned acreage and devastation was a shock to the Nation. Since that time, improvements in organization, mechanization, and financing of protection forces have made a big change. Destruction of the coniferous slash from early logging and conversion of large acreages to less inflammable timber types also reduced the hazard. The result has been practice of forestry at a reasonable risk.

Forces are now at work to increase the risk of loss from fire. A cycle of aspen invasion is being reversed through both planting and natural conversion. Timber harvest is on the increase, leaving ever greater slash accumulations. The resulting forest is becoming more inflammable. More forest users increase the likelihood of fire. In addition, the value of inflammable conifer growing stock is increasing.

These forces justify more emphasis on fire research than present financing will permit. In addition, investigations of possible beneficial use of fire for seedbed preparation, wildlife habitat improvement, and control of undesirable vegetation need greater attention. Research progress shown below, therefore, is limited in relation to need.

The almost 1½ million acres of successful pine plantations in the Lake States, the steadily increasing rate of planting, and the susceptibility of young conifers to total destruction by fire present an important fire control problem.

Fire Fuels in Red Pine Plantations Studied
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A new Station publication, *Fire Fuels in Red Pine Plantations* (Station Paper 68), gives the results of a study undertaken to provide a better understanding of the relationship of fire fuels to stand condition. Good sites and close spacing of trees both promote rapid buildup of fuels but shorten the period when fire is likely to crown. Early crown closure also brings about early suppression of hazardous grass fuels. Poor site quality and more open spacing of trees delay the buildup of fuels; but both stretch out the period of time during which a running ground fire may crown.

Chemical-Retardant Tests in Fire Control

The Station, in cooperation with the Chippewa National Forest and the United States Borax and Chemical Corporation, conducted a pilot study aimed at establishing basic criteria for the application of sodium-calcium borate suspensions on specific fuel types.

These preliminary tests indicate that successful use of borate mixtures on northern Minnesota sedge-cattail marsh fuels will require that (1) lines be more than 4 feet wide, (2) dosage levels be at least 1.8 gallons of mixture per 100 square feet of line for freshly prepared lines and at least 2.5 gallons per 100 square feet for lines prepared a day or more in advance of burning, (3) application of borate slurry be under high pressure--at least 400 p.s.i.--in dense sedge cover, (4) pump capacities be in excess of 20 gallons per minute to give significant coverage within reasonable time limits on a going fire, and (5) the retardant slurry be properly mixed for consistent results.

Controlled Burning Effects on Several Cover Types

During 1958 the Station started controlled burning experiments in northern Minnesota in cooperation with the Chippewa National Forest and the Division of Fish and Game of the Minnesota Conservation Department.

The experimental areas were selected so that study could be made of the effects of fire on brush (primarily hazel and redosier dogwood), aspen, and birch cover types.

Five burns made in the spring and three in the fall indicated that a light surface burn will not only kill the aboveground portions of all the brush but also many of the hardwood saplings in the 1- and 2-inch diameter classes. Where the fire intensity was higher, the larger hardwoods were also killed. Spring burning in all cases has been followed by sprouting and suckering so that in many places the number of brush stems now present exceeds the original stand. However, where slash was

also present, the new sprouts are not only less numerous than before burning but are also smaller and less vigorous than those where the fire was less intense.



In this light burn the aboveground portions of all the brush were killed; in spots of higher intensity the larger hardwoods were also killed.

Forest Insects

H. J. MacAloney, Division Chief

In the 5-year period since forest insect research and survey activities were transferred to the Forest Service, considerable progress has been made in broadening regional activities. Additional funds have made possible some staff increases and the assignment of four men to field units. New staffmen this year are Louis F. Wilson at St. Paul and Robert L. Talerico at East Lansing, Mich.

Research on two major projects--the larch sawfly and the Saratoga spittlebug--has been completed; a Technical Bulletin on the larch sawfly is now being printed while a manuscript on the spittlebug is being reviewed. Two new major projects have been established. One, on the European pine shoot moth, is being carried out in Lower Michigan where this insect has caused heavy damage in many red pine plantations. The other is a study of insects affecting aspen and their possible relation to Hypoxylon canker. Research on the spruce budworm project is progressing favorably; population surveys and natural control studies as well as cutting practice and loss studies should be continued until the decline of the infestation.

The Division is keeping timberland owners and operators in the Lake States informed of the forest insect situation through publications and meetings. Seven Forest Pest Leaflets, covering insects common to the region, have been published; three more are in preparation. Numerous articles have appeared in forestry and entomological periodicals. In February the annual survey meeting in St. Paul stressed the need for more information on growth impact and losses due to forest insects. In September the Station acted as host at the Kawishiwi Experimental Forest for the annual Central International Forest Insect and Disease Conference.

Although the forest insect research program is progressing, the Station is still confronted with two basic problems. First, many forest insect problems are still being neglected. In this category are insects attacking cones and seeds, the development of new tree strains that are more resistant to insect attack, the relationship between forest stand characteristics and insect populations, and improvements in survey techniques. Second, the small technical staff and lack of adequate laboratory facilities limit the approach to many basic problems. Some progress has been made in acquiring additional field laboratory space, but more specialized technical equipment is needed to give impetus to the Division's research program.

Spruce Budworm
Biological and Ecological
Studies Progressing

Biological and ecological studies at the Kawishiwi Field Laboratory on the spruce budworm have resulted in two publications on the classification of larval instars--a modified

sampling technique for egg-mass populations, which reduces the size of the sample as much as 40 percent without impairing its efficiency; and a possible similar technique for early larval collections, now undergoing field tests.

Responses to contact and light stimuli and host and site preferences for oviposition are being tested by various methods, including the use of light cages and two types of olfactometers. Some results suggest that certain conditioning factors, such as the particular tree species the insect feeds on, may be involved in the choice of host for oviposition.

Current studies have now provided sufficient data on causes of budworm mortality to permit the development of annual life tables. Over 50 percent of mortality is caused by 20 known species of parasites, specimens of which were reared from the annual egg, larval, and pupal collections. However, parasitism to date is still below the level of effective natural control.

Another study correlating population fluctuations with tree characteristics may provide guides for developing silvicultural practices to combat recurrent epidemics. With this objective, data on budworm populations and individual tree characteristics, such as crown length, crown class, crown level, age, and vigor, have been recorded annually from nine study plots.

To evaluate the impact of budworm damage, losses caused by defoliation must be separated from those due to other factors. To obtain this information, 8 pairs of $\frac{1}{2}$ -acre plots in uniform balsam fir stands were established in the Ely and Crane Lake areas. One of each pair was randomly



Balsam fir branches from a pair of plots under study for effects of spruce budworm defoliation. Branch at left is from a sprayed plot; branch at right from an unsprayed plot.

selected for annual aerial spraying to prevent defoliation. Detailed tree and stand measurements will permit a comparison between defoliated and undefoliated plots for mortality, growth loss, top kill, and stand characteristics related to budworm susceptibility and vulnerability.

Studies are being carried on, with the financial assistance of the Office of Iron Range Resources and Rehabilitation, to determine the effects of cutting practices in spruce-fir stands on the intensity of defoliation and tree mortality attributable to spruce budworm attack.

In 1957 three adjacent uniform blocks of spruce-fir, each about 25 acres, were selected for the tests. Each block had sufficient volume to be logged as a regular commercial operation, but stands were young enough to insure a final harvest crop 10 to 15 years hence. One block was cut with conventional commercial clear-cutting standards; one was partially cut, leaving 60 to 65 square feet of basal area per acre in spruce and fir; and the third block was left uncut as a check. A replication of this test was installed in 1958, and another is scheduled for 1959. Results will aid in formulating an improved risk-rating scheme and in developing management practices for reducing damage.

Forest Management--
A Possible Tool
for Reducing
Future Budworm Losses

Wood-infesting insects--borers, bark beetles, etc.--play an important role in the deterioration of trees weakened by successive heavy budworm defoliations and of pulp sticks left in the woods during the summer months following a control cutting operation.

A study has been established in one of the cutting-practice areas to observe the sequence and time of attack by various insects and the development of damage and loss in pulpwood. Half of the sticks cut for this test were peeled and half left as "rough" wood. The peeled sticks were not affected. The unpeeled sticks, however, were attacked by some wood-infesting species within an hour after cutting. Altogether, 12 species were collected, and the pulpwood was heavily infested by the end of the summer. Sticks piled in the open were also more heavily infested

Secondary Insects--
A Serious Problem in
Budworm Salvage Operations

Studying insects attacking wood salvaged from budworm-defoliated balsam. Conventional piles of peeled and rough pulpwood are sampled for moisture content, and sequence and time of insect attack.



than those in partial shade. The extent of wood loss will be determined next summer. The information obtained will also be applicable to weakened standing timber.

**New Results on
Direct Control of
European Pine Shoot Moth**

Concentrated DDT sprays, applied by mist blower against the overwintered larvae in the spring or against the young larvae in the summer, will reduce shoot moth populations by at least 90

percent. In 1958 a 2½-percent spray, at the rate of 50 gallons per acre on trees 4 to 6 feet tall or 35 gallons per acre on trees under 4 feet, was tested in infested red pine plantations by the Lower Michigan National Forest in cooperation with the Station. Spring treatment can be carried out in Lower Michigan in April; summer treatments should be in late June or early July. Costs will average 12 to 15 dollars per acre.



Mist blower spraying red pine with insecticide to control a European pine shoot moth infestation.

**More Emphasis on
Preventing Buildup of
Shoot Moth Populations**

Research emphasis in 1958 changed from direct control of established infestations to the prevention of buildup of injurious populations through natural control factors. By life-table

studies the mortality of several shoot moth populations under different plantation conditions is being followed from the egg to the adult stage. The causes as well as the degrees of mortality are being recorded periodically. Previously unsuspected factors have already become evident, and from several years' life tables in different environments the events responsible for population increase and decrease or other phenomena will be determined.

Preliminary investigations in 1958 in the field of biological control show that importing and colonizing European parasites have promise. Usually less than 10 percent of the shoot moth population is killed annually by native parasites in Michigan. A much greater toll is taken by parasites in Europe, but European parasites are absent in most problem areas in the United States. A survey in eastern Lower Michigan near the Canadian border has revealed the presence of at least one foreign parasite. This species, Orgilus obscurator, is the most prevalent and widespread shoot moth parasite in Europe. It appears to be spreading slowly westward into Michigan from releases in Canada made over a period of years. Its successful natural establishment in Michigan makes it highly eligible for further colonization.

The selection of tree species resistant to attack by the shoot moth has been suggested for areas where severe attacks have been common. Studies in 1958 in Ottawa County, Mich., a focal point of severe damage, showed that pitch and Virginia pines are almost immune; jack and white pines proved only slightly susceptible; while Scotch, Austrian, and ponderosa pines were in a medium range. Red pine, however, was five or more times as susceptible as any other species tested; hence studies are under way to determine the food and shelter produced by red pine plantations with different growth rates.

Good growth conditions and tree vigor have prevented serious buildup of the European pine shoot moth in this red pine plantation. The tree indicated in the picture was attacked when it was about 3 feet tall, but growth added since that time has almost eliminated the crook caused by the attack.



A knowledge of the year of initial attack and the ultimate impact of the injury in forest plantations is of paramount importance in determining needs and justification for control operations. A back-dating technique, accurate to within 1 year, has been developed. One plantation examined has been infested for 6 years; yet good growth conditions and tree vigor have prevented serious and damaging population buildup. In another plantation some evidence suggests that differences in the intensity of attack within this plantation are due to growth conditions and site influences. These studies will be important in evaluating damage and in studying site differences.

Aspen Insects Study
Initiated in 1958

A study was initiated this season to investigate the importance of aspen insects in the complex of factors causing the early deterioration and death of aspen stands. The increased value of aspen in the Lake States has focused attention on management problems, and the stem borers are high on the list of important studies. These pests cause considerable direct wood loss through their tunneling habits, they weaken the stems and make them susceptible to windthrow, and they provide openings for the establishment of various rots and decays. Furthermore, they have been implicated as infection court agents for the highly destructive Hypoxylon canker disease.

Preliminary investigations are centered on a field study of poplar borer prevalence in relation to various stand conditions in a limited area in northeastern Minnesota. Several tentative conclusions can be drawn:

(1) There is no simple, direct relation between incidence of borer attack and Hypoxylon canker, (2) in stands having an average d.b.h. of 5



Poplar borers weaken aspen stems and make them susceptible to windthrow. They also provide access for decay organisms. Left, larval "push-out" hole; right, pupal chamber.

inches or less, successful borer attacks are found on trees having the same or a slightly larger d.b.h. than the stand average, and (3) on the basis of data from circular 1/10-acre plots there is no relation between incidence of borer attack and tree density or basal area, but there are slightly fewer trees within a radius of 5 feet of attacked trees (1.85) than unattacked trees (2.11) (150 observations each in a 30-year-old stand). None of the stand factors investigated during the preliminary study has an obvious influence on the incidence of poplar borer attack. Yet some such influence must exist, considering the great variation in percent of trees attacked in various portions of any particular aspen stand.

Future studies will be directed more toward the details of the biology and behavior of the stem borers, such as determination of (1) life-stage duration and periods of peak adult emergence, (2) preference and survival of the insect in trees of various ages and physiological conditions, (3) direct and indirect effects of various weather conditions on the insects, (4) reproductive and dispersal potentials, and (5) natural control factors. This information must be obtained to efficiently conduct quantitative studies of the insect population and tree damage and to determine possible means of silvicultural or artificial control.

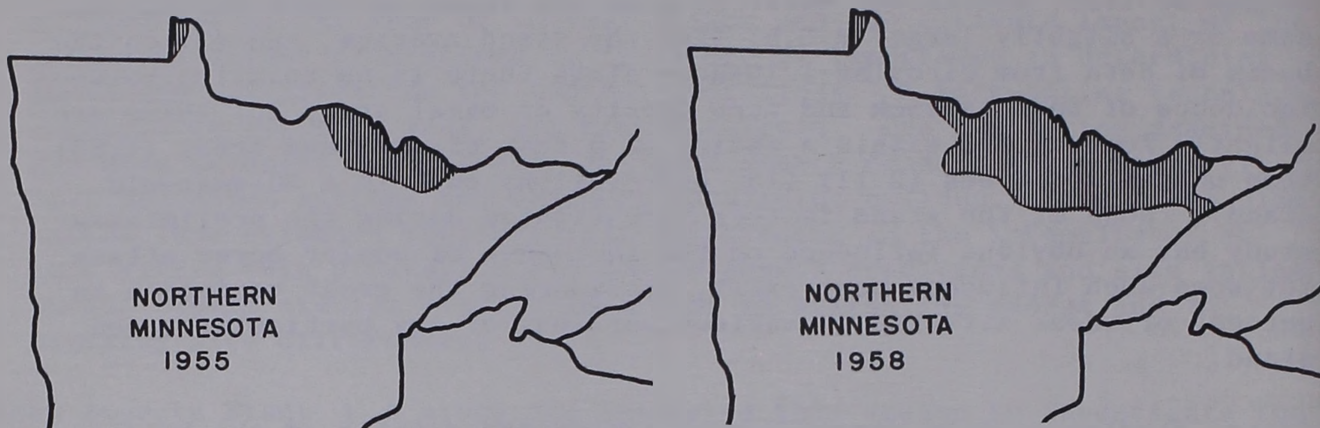
The possible role of aspen insects in the spread and development of Hypoxylon canker was also studied under laboratory conditions. More than 400 surface-sterilized bits of inner bark, taken from areas of insect oviposition and feeding injury, failed to yield any typical cultures of the Hypoxylon fungus. The fungus was consistently obtained from similarly treated material taken from the advancing margins of established cankers. This study must be greatly expanded and refined before any significant conclusions can be drawn. It will be continued in 1959, and an effort will also be made to obtain very young cankers in order to determine the condition of the bark prior to infection.

The Station has the responsibility of conducting and coordinating detection and appraisal surveys throughout the Lake States.

Detection and Appraisal Surveys Are Important Station Functions

The 1958 aerial survey for spruce budworm infestations showed that this epidemic had increased in severity. Of nearly 2 million acres of spruce-fir type covered, over 960,000 acres had suffered moderate to heavy defoliation, and an additional 380,000 acres were lightly defoliated (see map next page). In some locations where heavy defoliation had occurred for 3 years, top killing is now evident and tree mortality can be expected.

Adult spittlebug sweep surveys made by the Station in August indicated that approximately 3,300 acres of red pine plantations on the national forests in Wisconsin and Michigan may need treatment in 1959. About one-third of this acreage is on the Lower Michigan where control has not been carried on for some years. All but 151 acres of the remainder are on the



Increase in area heavily defoliated by the spruce budworm since 1955.

Lakewood District of the Nicolet and on the Rapid River and Manistique Districts of the Upper Michigan. Only 30 acres are on the Chequamegon, and for the third consecutive year no spittlebug control work will be needed on the Ottawa.

Jack-pine budworm infestations collapsed, generally speaking, over the entire Lake States area. Heavy parasitism was evident in most areas, and in many cases the foliage condition was satisfactory and recovery of the trees was apparent.

Tent caterpillar populations increased in a number of localities. Approximately 180,000 acres of aspen north and west of Duluth, Minn., were completely defoliated by the forest tent caterpillar, and in addition feeding was noticeable on about 625,000 acres. Heavy feeding was reported over a relatively large total acreage in a number of localities in northern Wisconsin. For the first time since 1950, Michigan reported no defoliation by this insect. In North Dakota this species and the Great Basin tent caterpillar defoliated about 3,000 acres of mixed hardwoods on the Sullys Hill Game Refuge and the Fort Totten Indian Reservation; high egg-band counts indicate the necessity for control in some areas next spring.

Walkingstick egg surveys on the Menominee Indian Reservation, Wis., show that about 300 acres of oak-basswood stands will be defoliated in 1959. An aerial spray operation is proposed to prevent further defoliation as well as migration into higher value noninfested woodland to the west.

Studies to Improve Aerial Survey Techniques Continue

The large acreage to be covered, the limited manpower and time available, and the inaccessibility of much of the infested areas make aerial surveys a cheap and practical way to detect and appraise forest insect damage except on relatively small areas where ground surveys are practical.

Realizing that the diverse timber types in the Lake States make existing aerial methods inadequate, the Station, in cooperation with the Beltsville Forest Insect Laboratory, carried out a study in 1957 and 1958 to develop more accurate techniques for surveying forest insect damage. The two main objectives were to ascertain the minimum height of flight necessary for accurate observations and to determine whether color photography with stereo coverage can be used efficiently for estimating different degrees of defoliation. The data have not yet been analyzed, but one conclusion can be drawn now: In general, the lighter the defoliation the lower the height of flight necessary to get a true evaluation; safety requirements, however, limit this to 500 feet.

The Station provides technical assistance on control operations to the national forests and, upon request, to other Federal, State, and private groups when appraisals by Station entomologists indicate that control measures are justified and needed. In 1958 assistance was given on several control projects at a number of locations.

Technical Assistance Provided for Control Projects
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Approximately 12,000 acres of spruce-fir type on the Kabetogama Peninsula in northern Minnesota were sprayed in June with DDT to prevent further heavy defoliation by the spruce budworm until logging operations could be carried out. Postcontrol surveys indicated that results were satisfactory; defoliation and egg masses were substantially reduced compared with untreated stands nearby.

For the second year weather factors apparently had a definite effect on Saratoga spittlebug populations. As a result, on national-forest red pine plantations in Wisconsin and Upper Michigan only 3,800 acres of the 8,000 originally proposed were treated with DDT. More than half of the treated acreage was on the Lakewood District--the southernmost one on the Nicolet National Forest--where temperatures lethal to the young nymphs did not occur.

In conjunction with the spittlebug control projects, 58 acres of red pine plantations on the Nicolet and Upper Michigan Forests were sprayed to control the red-headed pine sawfly. Numerous small "spot" infestations were ground sprayed. A lindane aroclor solution completely controlled the white-pine weevil on Norway spruce on the Ottawa National Forest.

Forest Diseases

Ralph L. Anderson, Division Chief

In 1958 the regional disease research program was conducted by a staff of four with the assistance of several cooperators. Work continued on several long-term studies such as Hypoxylon canker, oak wilt, white pine root rot, white pine blister rust as related to microclimate, blister rust races, and stem rusts of jack pine. Serious new problems, however, demanded much of our attention. Foremost among these was maple blight, on which a cooperative research and survey program was developed with the University of Wisconsin and the Michigan and Wisconsin State Conservation Departments. Strong financial support was given by the Northern Hemlock and Hardwood Manufacturers Association, the Maple Flooring Manufacturers Association, and the Birch Club. The Station also had valuable assistance on this problem from Dr. D. W. French of the University of Minnesota and Dr. G. A. Hesterberg of the Michigan College of Mining and Technology. Another new disease problem which came to the forefront was a nursery root rot of black spruce. This caused heavy seedling losses in three nurseries.

The number of serious disease problems that must be given attention is large in relation to the size of the disease research staff. This precludes the concentrated effort needed to make rapid progress in resolving many of them. In addition, a number of important diseases in the region, such as decay in northern hardwoods and mortality in red pine plantations in the Upper Peninsula of Michigan, cannot be investigated without spreading the present staff too thin for effective work.

Activities on major problems during 1958 are summarized briefly below.

Maple Blight Situation Under Investigation

During 1957 a condition termed "maple blight" appeared in Florence County, Wis. Characterized by the rapid killing of all hard maple regardless of size, it has caused serious alarm among foresters, timber owners, and industry in the region. Cooperation to study the problem developed quickly between the forest industries, the Lake States Forest Experiment Station, and State organizations. Industry is giving financial support, while the Station is coordinating the efforts of the various organizations.

The disease did not intensify during 1958 to the extent feared at the beginning of the season. This, however, does not mean that a serious hazard is no longer with us. The cause of blight and the reason for its appearance in 1957 have not yet been determined, and its potential for future damage is unknown.

Individuals and cooperators throughout the region were asked to report

Location of maple blight areas
in Wisconsin: 1, original
area that appeared in 1957;
2, new area reported in 1958.



any new cases of possible maple blight to this Station. A number of reports were checked to determine if the symptoms were similar to those in Florence County. Of reports received on 16 areas in Michigan and Wisconsin, 1 area was found to have blight symptoms. This was in Iron County, Wis.

Ground and aerial surveys were conducted in the original blight area to delineate its boundaries. These will be used in determining area affected and also as a basis for evaluating possible spread of the disease.

In an effort to learn the cause or causes for maple blight, several individuals devoted all or part of the past field season to a study of the problem. The Station has undertaken an environmental study, with one man spending the entire field season in the area. Ninety-three permanent survey plots were established. Preliminary analysis of data from these plots indicates that the blight tends to be more common on areas with poorly stocked pure maple stands.

Work by the University of Wisconsin is being carried out to learn if a fungus or insect is responsible for maple blight. Isolations have been made from trees having wilt symptoms (see picture next page). Inoculation of healthy trees with these isolates has not yet produced blight symptoms. Another growing season is needed for adequate evaluation. Many insects were collected in both the blight and nonblighted areas. Identification of these insects is under way. Specific studies are being carried out to learn if leaf rollers and webworms are playing an important role in the mortality of maple.



Typical maple blight symptoms. Note reproduction in foreground has been partially killed back. The large tree in center is almost dead. Advanced symptoms are shown on tree to extreme left. Florence County, Wis. (See discussion preceding page.)

Progress Made on Jack Pine-Sweetfern Rust Study

A jack pine-sweetfern rust study started in 1957 was continued this year. Field investigations have shown that the rust is present in areas where sweetfern is not found, but that another alternate host, sweetgale, enables the disease to infect pines.

This disease has a twofold effect on trees. It first deforms the stem to such an extent that the infected portion is often culled because the bark is difficult to remove. In addition, the diseased areas on trees serve as points of entry for wood decay organisms. Once established, the decay may advance a considerable distance beyond the area actually affected by the rust, thus greatly increasing the amount of material that must be culled.

Nursery seedbed inoculations of jack pine have been made. The objective is to obtain information on rust establishment and development and also to determine what symptoms appear at various stages in the life of the tree.

Disease Survey Made in Wilderness Area

A disease survey was conducted in the Roadless Area of the Superior National Forest during the summer of 1958--probably the first such survey in that area.

While it was general in scope, primary emphasis was given to evaluating the various rusts on jack pine. Although infected trees are scattered throughout the area and the alternate host, sweetgale, is very common, rusts are not present in amounts sufficient to cause a management problem.

Most of the jack pine is mature and as such is largely immune to additional infection. However, when regeneration becomes established, stem rusts could present a real threat in the area.

Some of the other observations made on this trip indicate that Hypoxylon canker on aspen is quite common and that the older aspen stands are heavily infected by heart rots. Occasional birch trees were noted to have premature yellowing of the foliage caused by a leaf-mining insect and a leaf-spotting fungus. Needle rust was observed on black spruce. No dwarfmistletoe was found, but it is known to be present in the area.

The Station, cooperating with Michigan State University, is attempting to determine the cause of a white pine root rot condition at the Chittenden Nursery in Wellston, Mich. A graduate student from the University spent the last 2 years working on this problem. The results should be available in the near future.

Nursery Root Rot
Studies Progressing

Reasonably adequate control of the root rot is being obtained with a treatment developed in earlier studies. This method, involving the use of methyl bromide on the soil prior to planting, has become more practical through the development of a mechanical method of applying the chemical and handling the plastic covering for the beds.

Some attention is being given to a similar root rot of black spruce that is causing serious losses in three nurseries. One of these nurseries also suffered severe losses in red pine from a root rot this year. It appears that nursery root rots will need the continued attention of disease research personnel.

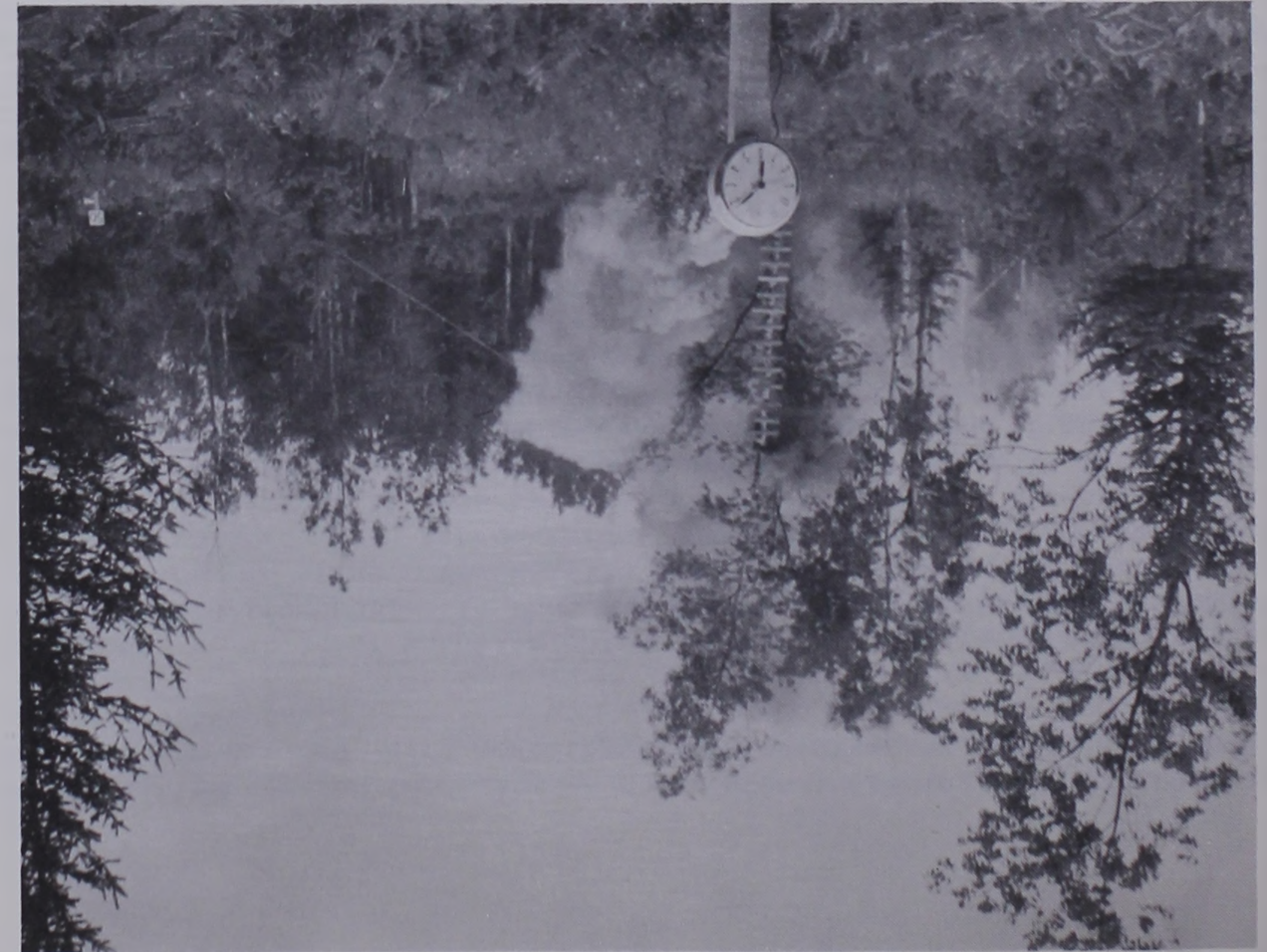
Hypoxylon canker ranks as one of the most important timber diseases in this region. Recent surveys have shown that it is responsible for killing a volume of aspen approximately equal to the amount harvested annually by the various timber-using industries.

Comprehensive Analysis
of Hypoxylon Data Begun

The Station has devoted considerable effort to this problem for several years with the cooperation of the pulp and paper industry, the Iron Range Resources and Rehabilitation Commission, and the University of Minnesota.

During 1958 approximately 75 aspen plots were remeasured to determine the prevalence of Hypoxylon canker in Minnesota. The data show that the level of infection has increased. In 1957, 2.4 percent of the trees were infected; this year the rate rose to 3.2 percent.

Most of the present effort is going into a comprehensive analysis of all available data that have been gathered over a 9-year period. This analysis has just begun and, although electronic data-processing machines will be used to speed up the work, it will be some time before the results are available.



Colored smoke bombs are used to trace rust-spore movement.

Forest Wildlife

L. W. Krefting, Project Leader

The Lake States deer harvest of 180,000 animals during the last year of record was approximately one-fourth of the total harvest in the United States. Hunters also ranged the forest for grouse, rabbits, squirrels, and other kinds of wildlife. Near the large population centers of the Midwest, forest lands play an important part in supplying recreation opportunity. Thus the 53 million acres of commercial forest land in the Lake States provide not only the raw material for wood-using industries but also some of the Nation's best recreational areas, particularly for hunting and fishing.

Wildlife in the forest is dependent on it for food and cover. On the other hand, some species may have quite an influence on the forest. This may be neutral, beneficial, or damaging, depending on the species of animals, the condition of the forest, and the management that each receives. The objective of wildlife research is to learn what these

In the northern part of the region where serious infection is widespread there are localized situations in which the generally prescribed Ribes eradication program does not give adequate control. Studies have been started in such areas to find out where the infection is coming from by using colored smoke bombs to trace rust-spore movement during conditions favorable for infection. The results indicate that rust can travel to the pines from Ribes at a greater distance than was previously believed. This is especially true under certain localized conditions, and studies will be continued to better define these situations.

Further study has substantiated the results of previous years; that is, in much of the southern portion of the Lake States region microclimate is the major factor influencing the distribution of serious blister rust infection. At present a major publication is being prepared that describes the localized conditions under which serious infection occurs and shows that in much of the southern Lake States area white pine can be grown with little risk even though Ribes are present.

Progress Made in Study of Microclimate and Its Influence on White Pine Blister Rust

Facilities Improved
for Studying Races of
White Pine Blister Rust

Propagation of test materials has been a major accomplishment in the study of white pine blister rust races. Approximately 300 pine grafts were made during the spring using scion material from various pine species that differ in susceptibility to rust infection. These will be used to test for variability in pathogenicity of rust races. An air-conditioned chamber was completed during the summer in our St. Paul greenhouse. Within the chamber temperatures suitable for rust development can be maintained even though temperatures in the greenhouse are above 90° F. Thus, inoculation studies may now be conducted under weather conditions which formerly forced abandonment of this type of work.

In 1958 it was found that the area of infection in established centers was expanding at a slower rate than in either 1956 or 1957. On the other hand, the number of new centers becoming established increased during the current year on three of the areas sampled. An exception to the latter trend occurred in the northernmost Minnesota area where the number of new centers was greatly reduced. This area is on the northern boundary of the disease's range, and it is thought that perhaps the cool, dry weather early in the season may have been a contributing factor in bringing about this decline.

Increase in the
Number of New
Oak Wilt Centers

A fourth annual oak wilt survey remeasurement was completed this year. This survey involves 2 central Wisconsin counties and 2 areas in southeastern Minnesota. Its purpose is to determine the rate of expansion of oak wilt infection centers and also the rate of new center establishment.

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relationships are and to determine means of maintaining wildlife populations at the desired level consistent with maintaining cover, food supply, and other use.

To improve or at least maintain suitable deer habitat is perhaps the most critical wildlife problem in the Lake States. Severe winters may lead to over-use in some areas. Progressive depletion of the browse supply is likely to follow. Tree reproduction, necessary for sustained timber production, may be heavily used to make up the difference. Excessive populations of other wildlife species also may lead to damage to tree reproduction. Destructive hare, mouse, and porcupine feeding of this kind has been noted. Plantations may be injured severely during the early years of establishment. Finally, modification of forest use may be necessary to provide the right habitat for a species such as sharp-tailed grouse. At the root of all these problems is the need to maintain balance between wildlife numbers, the vegetation that supplies them food and cover, and conflicting demands for growing space.

Under a cooperative agreement with the Department of Interior, Fish and Wildlife Service, the Station has one wildlife research biologist assigned to it. In addition to working cooperatively with the Station, the biologist has some research projects with the University of Minnesota and the Quetico-Superior Wilderness Research Center.

There are numerous wildlife research problems urgently needing attention in the Lake States. Because of limited funds, emphasis in the present program is centered on only a few of them. Some recent results follow.

Herbicides a Tool for Improving Wildlife Habitat

The revolutionary expansion in the use of herbicides has provided wildlife researchers with both a problem--the destruction of forest vegetation for wildlife--and an opportunity--a potential tool for the improvement of wildlife habitat. Unfortunately, the results of such applications have never been systematically evaluated.

Vegetational surveys on upland forest types in Minnesota indicate a preponderance of American and beaked hazel and a low ratio of the preferred browse species such as the dogwoods, viburnums, and cherries. This overabundance of hazel, which is low in browse preference, reduces the carrying capacity of the range for deer.

Aerial applications of 2,4-D (ester formulation), at the rate of 2 pounds of acid per acre in $3\frac{1}{2}$ gallons of water, were made on eight 2-acre test plots in July 1958. Preliminary observations on the shrubs indicate that American and beaked hazel and willow had the most leaf kill, whereas the dogwoods, cherries, viburnums, honeysuckles, and the juneberries suffered little damage. Among the hardwood forest trees, paper birch and red oak were hardest hit, and aspen the least. Jack pine was damaged a little, and red and white pines were not affected by the spray.

Mountain maple is a staple and much preferred browse species over its botanical range in the Lake States, northeastern United States, and southern Canada west to the Prairie Provinces. The species can withstand heavy browsing, and in many wintering areas it furnishes the bulk of the available browse. It can regenerate by stem sprouts and root suckers and tends to grow in colonies, especially if disturbed by browsing or cutting.

Effect of Deer Browsing on Mountain Maple

A study was started in 1952 to determine the browse tolerance point of mountain maple, based on simulated and natural deer browsing, and to observe the natural browse habits of deer in relation to browse production. Tentative results on the clumps subjected to natural deer browsing show that the species responds well to heavy use and that the amount of regrowth after browsing is dependent on the amount of the annual growth eaten or broken during the browsing process. When 84, 88, and 93 percent of the annual growth was removed, the regrowth the next fall was 4 to 16 percent greater than the previous fall.

Preliminary findings for the simulated deer browsing part of the study indicate that clipping at all intensities resulted in fewer twigs. The weight of the browse increased for each clipping intensity with the exception of the 60-percent level where the weight remained the same. The total length of the annual growth produced was greatest for 20-, 40-, and 60-percent intensities, considerably less for the 80- and 100-percent test clumps, and least for the unclipped clumps.

The integration of wildlife habitat improvement with good forestry cutting practices is something which the public can rightfully expect from land-managing agencies. Such integration is especially important in coniferous swamps, which are a preferred wintering ground for deer. In fact, the winter range of the deer herd is only 10 percent or less of their summer range. Although many States have been cutting coniferous swamps to improve them for deer and other wildlife, few studies have actually been made to determine the best cutting methods in terms of food and cover.

Cutting Practices to Improve Wildlife Habitat

This was the objective of a study established in 1952 on the Upper Peninsula Experimental Forest. Measurements of the browse supply for deer before cutting and remeasurement 5 years later show that red maple, mountain maple, redosier dogwood, yellow birch, black ash, and sugar maple produced the most browse in the block, strip, and shelterwood methods of cutting--the shelterwood method being the most productive. From both a food and cover standpoint, however, the block and strip cutting practices were best.

Effect of Deer Browsing and Snowshoe Hare Clipping on Forest Vegetation

The regulation of the deer herd in the best interests of man can best be accomplished by local control. In some forest types, provided the deer population is not too large, browsing may increase the growth rate by thinning dense stands and improve quality by feeding on the lower limbs. On the other hand, a large deer herd may reduce the number of young trees below desirable limits and seriously damage quality and growth rate.

For the past 6 to 10 years the vegetation in 27 exclosures has been measured and remeasured. Tests in a jack pine plantation in Lower Michigan illustrate the kind of results obtained so far. Between 1949 and 1958 the survival of unfenced planted and natural jack pine trees was 55 percent compared with 95 percent for the fenced trees. Eighty-six percent of the unfenced trees were deformed by deer browsing, and only one tree was classed as a crop tree. The average height was 3.9 feet for the unfenced trees and 8.6 feet for the trees within the exclosure.

Forest Utilization

A. W. Toole, Division Chief

The forests of the Lake States are supporting a billion-dollar industry in the region. More intensive forest management and utilization could substantially increase present growth and make available a sound resource base for a multibillion dollar forest products industry in the years ahead.

The key words here are "sound resource base." Actually, the forests even now are growing twice as much cubic volume as is being used. But much of the unused growth is being added either to low-value trees and species which should be removed and for which adequate uses have not yet been developed, or to trees in dense stands which should be thinned but for which present harvesting methods are not economically feasible. The profitable use of cull and low-grade timber, little-used species, and small thinnings is a problem of major significance and is dependent for solution upon being able to get this class of material out of the woods economically. Utilization of this material will lessen forestry problems and extend timber supplies.

In the Lake States pulpwood markets are being developed for small hardwood timber, and industrial expansion based on such material is under way and should be accelerated. Methods of logging small quantities of hardwood thinnings profitably and without damage to the stand must be developed before the forest manager can use these markets to attain

maximum quality and volume growth on the millions of acres of hardwoods in the Lake States. The harvesting process should be used to further the objectives of forest management, silviculture, insect and disease control, and extension of the preferred species and forest types. Seasonal logging experiments in lowland and upland types might demonstrate methods of conifer regeneration and brush control. Conversion and processing equipment suitable for woods operations and use is needed for specific situations and qualities of material.

Major emphasis in 1958 has been on the use of preservatively treated wood on farms, methods of evaluating tree quality in northern hardwoods, the effect of various cutting intensities on stem quality, small-kiln production of charcoal from low-quality material, and the utilization of logging residues. An immediate future objective in new work will be to develop a program of research in timber harvesting and processing methods and equipment.

Fencing studies were continued in 1958, and investigations of the use of preservatively treated wood products for the farm were expanded.	<table border="1"><tr><td>Use of Treated Wood on Farms</td></tr></table>	Use of Treated Wood on Farms
Use of Treated Wood on Farms		

In cooperation with the School of Forestry of the University of Minnesota and the Wheeler Lumber Bridge and Supply Company, 100 red pine and 100 jack pine posts (3 inches by 6½ feet) were given a pressure creosote treatment, and a like number a pressure penta treatment. About one-third of the posts were analyzed for penetration, and the remainder were set in the Cloquet and Rosemount post test plots for observation during the life of the posts.

Construction on a 54x196-foot insulated and ventilated experimental turkey building was started in 1957 on the University of Minnesota's Rosemount Agricultural Experiment Station; it will be completed in 1959. Cooperators on this project are several branches of the University including the School of Forestry and the School of Agricultural Engineering, and the Lake States Station. Construction features include the location of the purlins on top of the poles, the use of steel for tension braces, a floating insulated wood ceiling with a slot air intake for ventilation, and the design of a fan system for removing moist air during the winter and for cooling the building during the summer.

All of the lumber used to sheathe the inside of the building was given a 3-minute dip in a 5-percent penta solution with a water repellent added. Fifty-four panels on the side walls (each about 3½ by 6½ feet) were built with native jack and red pine lumber and given various preservative treatments. Each panel was duplicated on both the east and west sides of the building. Materials used were nominal 1-inch lumber in 8-inch and 10- to 12-inch vertical stockboards and battens, and 6-inch drop siding panels attached vertically and horizontally.

The treatments used on each of the above four types of panels in addition

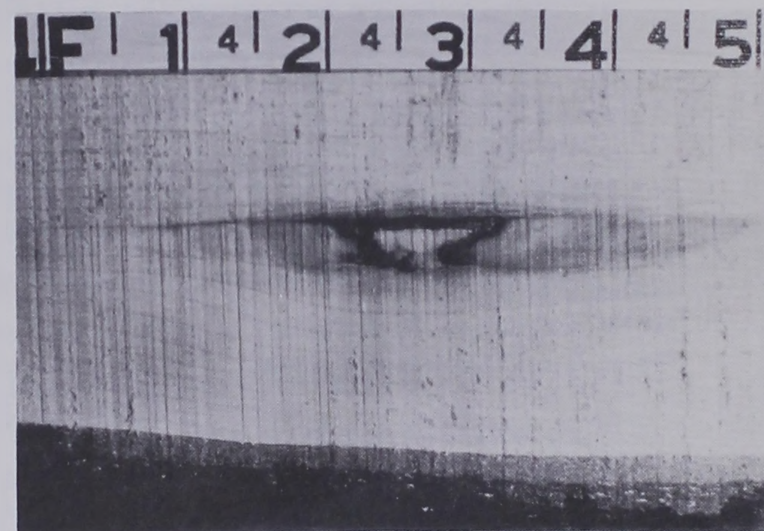
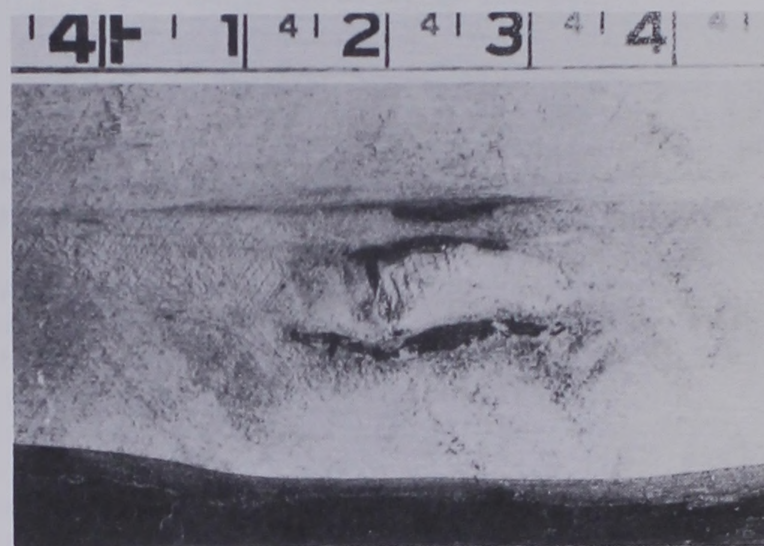
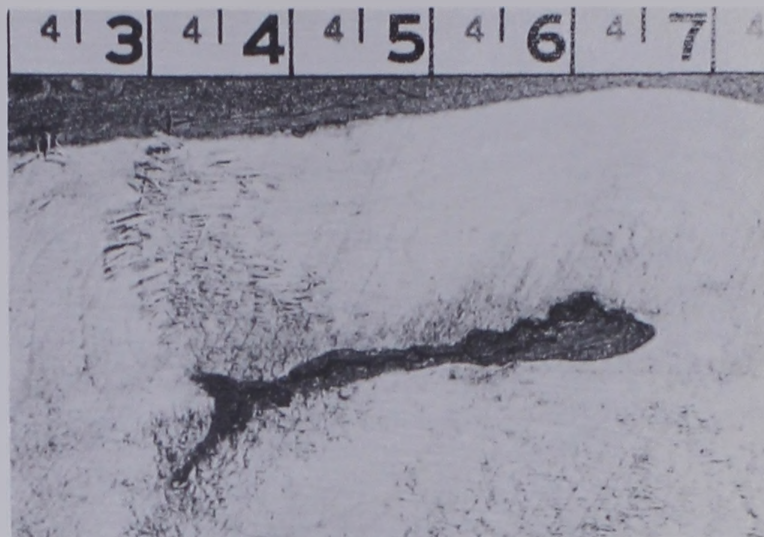
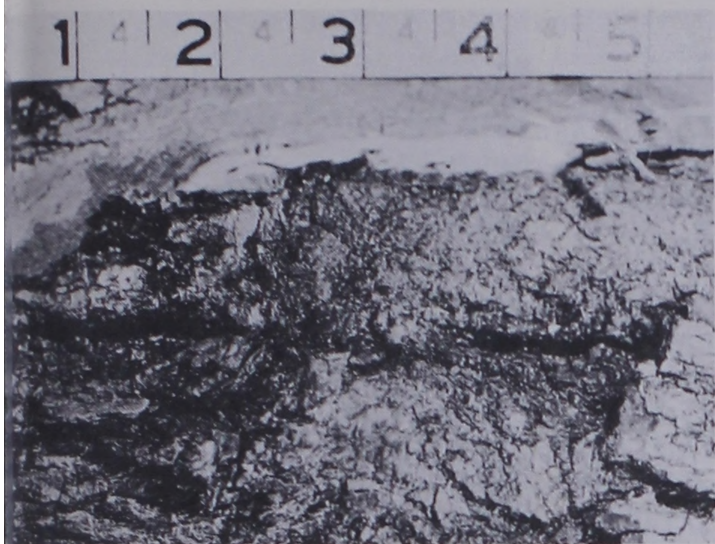


Novel features in construction, ventilation, and insulation are being tested by several cooperating groups in this experimental turkey building under construction at the Rosemount Agricultural Experiment Station.

to control panels were (1) two coats of outside paint, (2) a 3-minute dip in a 5-percent clear water-repellent penta solution with mineral spirits as a solvent, (3) the same as item 2 followed with 2 coats of outside white paint, (4) the same as item 2 with a brown pigment added, (5) a 3-minute dip in a 5-percent dark penta solution made with No. 2 fuel oil as a solvent, and (6) a 3-minute dip in a 5-percent copper naphthenate solution made with mineral spirits as a solvent.

Tree Quality in Northern Hardwoods

A northern hardwood timber-quality study initiated in 1955 has developed modern photographic and electronic data-processing techniques in a study of methods for evaluating the quality of standing timber. Basic information on quality-determining factors such as defect identification, origin, location, development, size, and total effect on wood quality are examined and recorded on color slides and punchcards. The series of photographs on the following page illustrate the method of developing and recording qualitative and quantitative data regarding exterior defect indicators and associated underlying defects.



illustrating an exterior defect indicator and associated underlying defect. Top left, appearance of an exterior defect in sugar maple. Top right, same defect 1 inch below the surface. Above, defect 2 inches below the surface. Middle right, defect 3 inches below the surface. Bottom right, defect 4 inches below the surface.

The photographic method of collecting data can replace hand methods of drawing log diagrams and recording yields and offers the advantages of speed, economy, accuracy, permanence of record, and ability to handle a larger sample and increase reliability of results. Color-slide data transferred to punchcards and analyzed by electronic processing equipment provides a quick, economical, and accurate method for handling large volumes of basic research data not practical for hand computing.

Analysis of a small sample of sugar maple indicates that standing trees can be evaluated within known limits of accuracy by examining the external characteristics of the tree. The value of the standing tree is related to such variables as the type, number, and spacing of defects; sweep; tree size; and growth conditions. This relationship is indeed a complex one. For this reason the possibilities of using modern data-processing techniques have been investigated, and indications are that this can readily be done. A simple device for punching data cards in the field can be utilized to record information on tree characteristics. From this point the entire process of evaluating timber quality becomes completely automatic. The field-punched cards would be forwarded to the data-processing office, where a pre-programed system of analysis for electronic computers would automatically apply the proper formulae and tabulate the values of individual trees for alternative products.

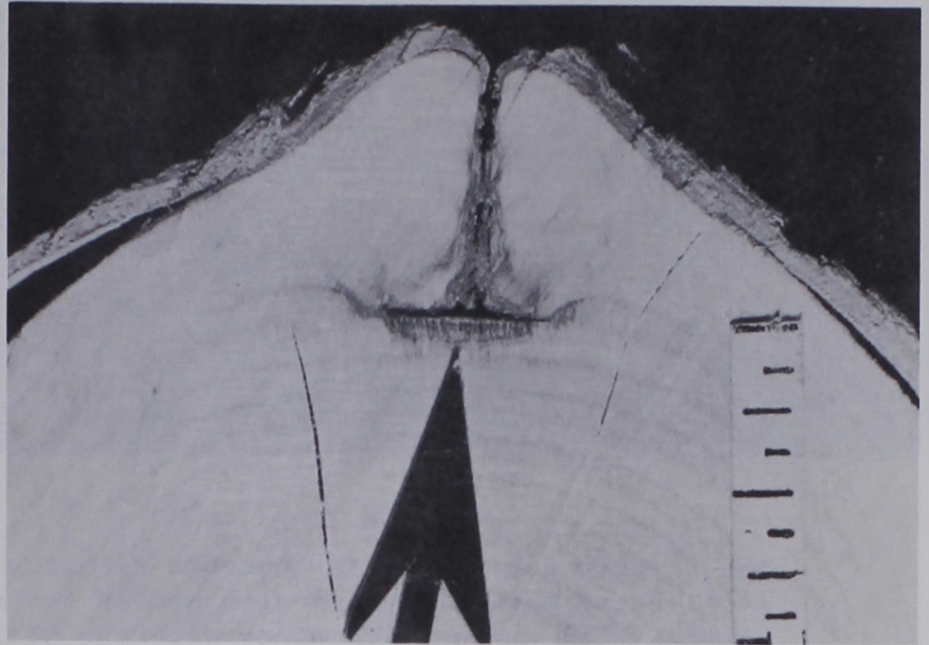
These techniques will be valuable in the formulation of tree-grading systems and their application in the field. Foresters, timberland managers, researchers, and people involved in the conversion of timber into products need reliable and efficient methods for determining the value of standing timber. Tree-grading systems developed in the past have been difficult to apply in the field within known limits of accuracy because they have relied on individual judgment or experience or were applicable only to limited conditions. The new system would overcome all of these difficulties by bringing the entire base of research data into value determination for each tree or log.

Now that techniques for collecting and analyzing basic timber-quality data have been developed, the collection of basic information for sugar maple will be started in 1959. The project will be extended to other species and timber types as rapidly as the work can be programed.

Relation of
Silvicultural Practice to
Tree-Quality Development

Initial fieldwork was completed this year on a study of young northern hardwood stands to be managed for maximum growth of high-quality trees. The effect of various cutting intensi-

ties on stem quality and growth is being investigated by making periodic measurements, diagrams, and photographic records of stem changes under each treatment. The quality of the trees will be evaluated on the basis of external stem characteristics and stem dissections following each periodic cutting. An attempt will be made to determine the origin and follow the development of various types of defects with the idea of preventing their recurrence.



Exterior view and cross-section of an overgrown swollen seam on a 7-inch d.b.h. sugar maple. This type of defect is serious and very common in sugar maple. A study now under way is investigating its cause and cure.

The study plots were cut to the designated stocking levels during the winter of 1957-58. The logging was a typical short-log, horse-skidding operation, and initial logging damage appears to be minor. Very few "leave" trees were completely broken off, and few trees have been damaged to the extent that present quality or growth of the trees will be appreciably reduced. The sample trees will be rediagramed and photographed periodically to follow the changes in exterior defect indicators and logging damage under each of the cutting intensities.

The treatment that yields the greatest volume of high-quality (that is, defect-free) wood will be selected by comparing the various stocking levels at the conclusion of the study. This investigation of tree quality may be the basis for determining recommended silvicultural treatment of young northern hardwood stands.

The production of charcoal in small kilns continues to expand in the Lake States. A leading producer of briquettes operated more than fifty 2-cord kilns.

Charcoal Production in Small Kilns

Another newly established briquetting plant received all of its charcoal from more than 100 small kilns. A number of other kiln operators produced lump charcoal for the retail market or for briquetting. Prior to 1956 there had been no small kilns operating in the region for many years.



A battery of small privately owned metal kilns producing hardwood charcoal from low-value bolts and sawmill residue.

The Station continued its charcoal research program to help provide this small but growing industry with needed technical and operational information. The cooperative study with the Cliffs-Dow Chemical Co. on the mechanics and economics of cordwood handling and charcoal production in small field kilns was completed during the season, and a publication summarizing results is being prepared. Structural design improvements incorporated in a 7-cord kiln were not tested conclusively in the series of 18 burns made during the study but will be evaluated in later analyses of structural designs for small kilns.

The two experimental kilns built in 1956 on the Argonne Experimental Forest were further tested. These kilns, incorporating new and improved designs, were used to investigate the factors affecting kiln efficiency, operating costs, and charcoal quality. Examples of the effect of such variables as wood weight, volume, moisture content, time, temperature, and air relationships on charcoal yield and production time are illustrated in the table on the next page.

A third experimental kiln of castable refractory was designed and built adjacent to the two earlier test kilns on the Argonne Experimental Forest in cooperation with a leading manufacturer of refractories and the Forest Products Laboratory. Preliminary tests of this kiln indicate that it will provide a relatively inexpensive unit capable of withstanding the severe temperatures encountered in wood carbonization.

These experimental kilns also served as demonstration units. Many people visited the facilities to observe the kiln operations and obtain information on wood carbonization. Numerous requests for assistance and information were also handled through correspondence.

Further charcoal research work will give emphasis to developing more information on the raw material and to integrating charcoal wood harvesting with forest management activities.

Effect of moisture content and firing method
on charcoal yield and carbonization time

Raw material ^{1/} and firing method	: Average : moisture : content	: Average : charcoal : yield	: Average : burning : time
	<u>Percent</u>	<u>Percent</u>	<u>Hours</u>
Air-dry wood:			
Single stack, end opposite stack ignited	26	29	22
4 stacks and center firing	35	29	13
Green wood:			
4 stacks and center firing	60	26	21

^{1/} All wood was unbarked sugar maple; sticks were 4 feet long and 3 to 10 inches in diameter. Three burns were made for the green wood and three each for the two firing methods for air-dry wood. The average volume per burn was 2.7 cords.

Experimental charcoal kiln
No. III. Outer walls are
common cinder block, 8 inches
thick. Inner walls are cast-
able refractory, 3 inches
thick. The ceiling is a
light-weight castable refrac-
tory, 6 inches thick.



Wood Harvesting
Studies

Cooperation was continued with the Michigan College of Mining and Technology in studies on utilization of logging residues. Such residues would find the widest market and utilization as bark-free chips suitable for use in the pulp and paper industry. Removing the bark from wood residues in the piece presents many problems due to the wide variation in the size and shape of the pieces. This study is to investigate the effect of outdoor storage of hardwood chips in piles on the ease of bark-chip separation and the extent of any preferential decay of bark under variations of season of piling, size of pile, and length of time in the pile. Instruments in the chip piles permit correlating periodic temperature and moisture readings with ease of bark separation, deterioration of cambium, decay of bark, decay of wood, and biological agents present.

Chemical Debarking
of Aspen With
2,4-D and 2,4,5-T

Tests started in 1956 in Lower Michigan revealed that the undiluted amine salt of 2,4-D applied to frill girdles was about as effective in loosening the bark of bigtooth aspen as similarly applied sodium arsenite. On oak only sodium arsenite was effective over a long enough period of application to have practical consideration. The bark-loosening effects of tests made on aspen in 1957 essentially corroborated the 1956 results and were as follows:

<u>Chemical</u>	<u>Method of application</u>	<u>Treatment effective in loosening bark if applied between--</u>
Sodium arsenite (40-percent solution)	To frill girdles	May 22 - August 16 (12 weeks)
	By paint brush to band, twice as wide as tree diameter, around tree	May 22 - June 5 (2 weeks)
	By backpack sprayer to band around tree	June 5 (1 week)
Amine salt of 2,4-D	In frill girdles	Not effective
	To frill girdles at 100 percent	May 22 - August 1 (10 weeks)
	To frill girdles at 50 percent	May 22 - July 26 (9 weeks)
	To frill girdles at 25 percent	May 22 - June 25 (5 weeks)

Watershed Management

Sidney Weitzman, Division Chief

Research in watershed management moved ahead at three of the Station's field units. At Grand Rapids, Minn., studies on snow and frost behavior under different cover types were completed. Wells were installed in a forested bog to study ground-water fluctuation. At the field unit in East Lansing, Mich., a study of soil moisture under different forest types was initiated to determine the effects of forest cover types on water use. A streambank erosion study on trout streams was completed. At La Crosse, Wis., a third field unit was established this year which will deal, initially at least, entirely with watershed management problems. A search for experimental areas was conducted at all three locations.

New Research Facilities

The Driftless Area, occupying over 8 million acres in southwest Wisconsin, southeast Minnesota, and northern Iowa and Illinois, has long been recognized as the most critical erosion and runoff problem in the Lake States. The continental glaciers bypassed this area leaving a dissected plateau, now weathered into an intricate drainage pattern. The hilltops and valley bottoms are both flat and usually farmed. The steep slopes in between are forested and for the most part grazed, overcut, and mismanaged. This two-storied type of farming on highly erosive soils has resulted in widespread and spectacular erosion, the worst of which is found on the wooded slopes. (See map and picture on next page.)

Watershed Research Started in Driftless Area
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The watershed research job is written all over the land. But the solutions may not be so obvious. They may require techniques as yet untried in our field.

The newly established field unit at La Crosse, Wis., will conduct research in this area. Richard Sartz, formerly of the Northeastern Forest Experiment Station, was appointed to head up the work. Selection of additional personnel is under way, and 1 or 2 technicians will be added to the staff.

The immediate jobs ahead include preparing a problem analysis, a necessary preliminary to planning a program, and selecting research areas or experimental forests for the conduct of long-range studies. The Wisconsin Conservation Department will buy the experimental forests and cooperate in other ways in this effort.

In the Driftless Area both the hilltops and valley bottoms are flat and usually farmed. The steep slopes between are forested. (See discussion on preceding page.)



Widespread and spectacular erosion, especially on the wooded slopes, is found in the Driftless Area.

Much attention has been given this past year to the selection of experimental areas for watershed management studies Stationwide. The extreme diversity of geology, soils, climate, and topography requires the use of a number of experimental areas, each one reasonably typical of the more extensive conditions it represents.

Research Areas
Selected

In the hilly Driftless Area the job is largely completed. From the many areas considered, one area has been examined in detail and is deemed ready for purchase by the Wisconsin Conservation Department.

The search in the Lower Peninsula of Michigan has narrowed to two possible areas. These cover the two major geologic and soil complexes as well as their intergrades. One typical complex is the sandy outwash flats covered with natural oak or pine plantations. In this area soundings to permanent ground water were taken to obtain a gradient in water-table depths from 1 to 30 or more feet. The other is the hilly moraine underlain with loamy sand to sandy loam soils, with a cover of northern hardwoods, aspen, or oak.

Reconnaissance of experimental areas in northern Minnesota has been limited. Surveys in this area will receive major emphasis in 1959.

Research Program

Short-range studies have been going on at all Centers. These studies are designed to get answers on individual hydrologic processes or on some of the more pressing soil and water problems in the area. These were:

Erosion from streambanks constitutes a major source of sedimentation in Michigan's streams and rivers. Heavy deposition and transportation of sediment not only lower water quality from a municipal and industrial viewpoint, but also choke stream channels, fill reservoirs, and destroy recreational and fish habitat values.

Streambank
Erosion Control

The Michigan Department of Conservation started a program of stream improvement in 1950. Work done includes upland works, such as tree planting, stream fencing, and gully control; stream structures such as deflectors and dams; and bank stabilization by rock riprap and seeding.

A survey of bank stabilization work on trout streams was undertaken during the summer of 1958 to check the effectiveness of these measures. A total of 107 treated banks and 80 untreated banks from 4 watersheds were examined. Evaluation of the information collected shows that treatments applied are very effective in reducing erosion. Waterlines on the treated banks are 93 percent stabilized, while on the untreated banks



Untreated banks are seriously eroded, whereas treated banks are largely stabilized.



they were 30 percent stabilized. Untreated banks were evaluated as being 47 percent seriously eroded (gullies, soil slippage or slumps, and undercutting) as compared to 9 percent in the treated banks. These results show that bank stabilization practices can materially reduce bank erosion, stabilize channels, and reduce the amount of sediment being carried by the streams.

Water Temperature Reduction by Spring- Channel Modification

In southwestern Wisconsin a study was made in cooperation with the Division of Fisheries, Wisconsin Conservation Department, to determine the temperature change caused by reducing the length of a channel of spring origin from 563 to 186 feet. The new and shorter channel was constructed by a small bulldozer.

Previous to diversion the water temperature, which was around 48° F. where the spring came from the ground, rose to 60° on typical warm summer days by the time it reached the nearby trout stream; after diversion it remained at around 49° or 50°, a temperature reduction of about 10°.

High summer stream temperature is one of the factors limiting trout production in this part of Wisconsin. Spring channel shortening appears to offer some assistance to the fish habitat manager as a means of lowering temperatures in certain springs with good flow, but with long meandering channels.

Soil freezing is a commonly observed winter condition in Michigan's Lower Peninsula. This soil characteristic is important in water management because it may adversely affect the recharge of snowmelt water to the soil moisture and ground-water reservoirs. It also contributes to spring flooding.

Soil Freezing Varies
by Forest Type

During the winter of 1957-58 the frequency and depth of concrete frost were observed to be greatest under dense red pine plantations where snow accumulation was lowest. Open fields were next in order of frost occurrences, with more and deeper frost observed on sandy soils than on clay soils. No concrete frost was found under hardwood forests.

Forest type also influences the rate at which frost leaves the ground. Frost was observed in dense red pine plantations longer than in adjacent open fields or hardwoods.

Single-ring infiltration runs made recently in northern Minnesota on soils with various frost types indicate that there may be considerable water movement through certain types of frozen ground.

Type of Frost
in Soil Affects
Its Permeability

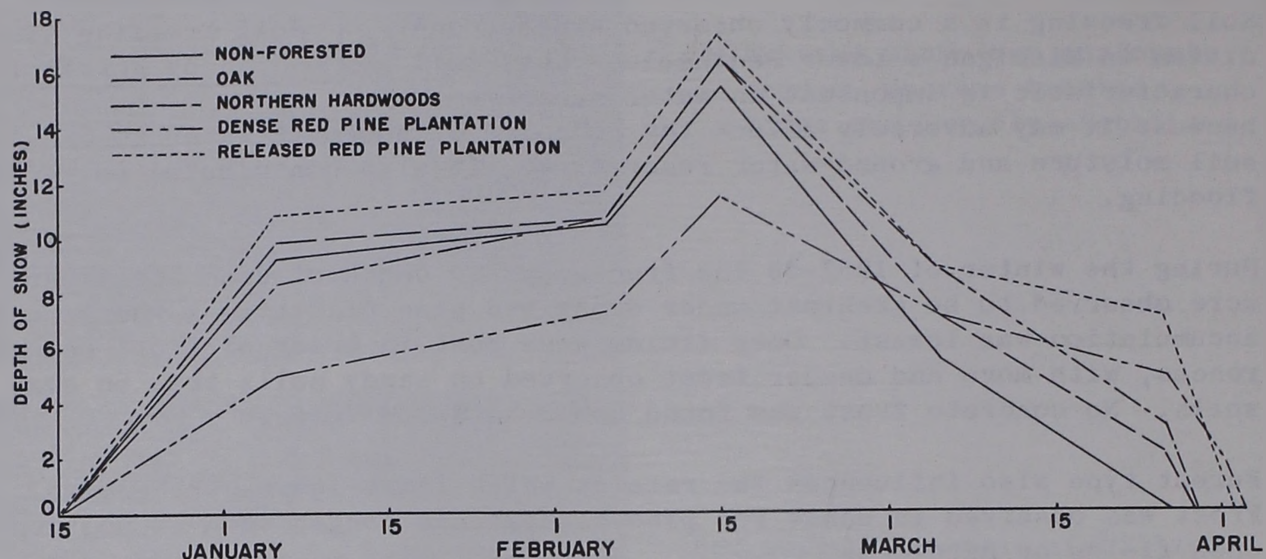
This is especially true in sands or loamy sand soils that are rather dry in early winter at time of freezing. In such soils a "dry-concrete" type of frost often forms. The infiltration rate in these soils is three or more times as high as in the more dense concrete frosts which usually occur in heavier textured soils with higher moisture content.

About 25 percent of northern Lower Michigan's precipitation occurs as snow. This snowpack forms the primary source of water available for recharge to the soil moisture and ground-water reservoirs.

Snow Accumulation
and Melt by
Forest Types

The amount of snow accumulation on the ground in the winter and the rate of snowmelt in the spring are influenced by the nature of the vegetative cover. The density of the crowns of the various forest types and the degree of crown closure appear to be the major factors influencing snow accumulation and melt. In a study in northern Lower Michigan, the leafless crowns in hardwood stands such as oak and mixed northern hardwood proved no barrier to snow accumulation. Neither did a thinned pine plantation. Both accumulated slightly more snow than the open fields at the peak of snow depth. On the other hand, dense plantations reduced the snow depth.

The rate of snowmelt depends largely upon the degree of shading offered by the various cover types. In this same study snowmelt rate was greatest in open fields, slightly less in open oak stands, still slower in northern hardwood stands, and least under the dense pine plantations. The chart on the next page shows the patterns of snow accumulation and melt for the winter of 1957-58.



Depth of snow within forest types during the winter of 1957-58, northern Lower Michigan.

Ground-Water Studies Started

An exploratory study in swamp ground-water relationships was begun during the past year. This study, an initial step into the unknown field of swamp hydrology in northern Minnesota, concerns itself with the measurement of water-table fluctuations within bogs and the adjacent upland areas. The picture on this page shows an observer gathering information from a water-level recorder near the edge of a black spruce bog. Exploratory studies like this will also attempt to develop techniques for installing recording and nonrecording wells to measure water-table fluctuations as they correlate with rainfall, transpiration, and timber harvesting or swamp-drainage treatments.



Continuous recorders measure daily and seasonal fluctuations in ground-water level.

List of Publications, 1958

Lake States Forest Experiment Station

General Forestry

Cross, Robert L. RESEARCH BY THE U. S. FOREST SERVICE ON MICHIGAN'S UPPER PENINSULA. Mich. Tech. Forester, pp. 42-44. 1958.

(A description of forest research facilities and results of the Lake States Forest Experiment Station on the Upper Peninsula of Michigan.)

Lake States Forest Experiment Station. ANNUAL REPORT, 1957. 45 pp., illus. (Processed.) 1958.

(The first part of the Report considers some of the most significant events in Station research during the year. The second and main part reviews research progress in reforestation, discusses some studies under way, and examines briefly some of the needs that have become evident.)

Rudolf, Paul O. S. R. GEVORKIANTZ, FOREST BIOMETRICIAN. Sci. 128(3338): 1557. 1958.

(Brief biography of S. R. Gevorkiantz and listing of his major achievements.)

Regeneration, Stand Improvement, and Harvest Cuttings

* Buckman, R. E., and Roe, E. I. EFFECTS OF PRUNING ON THE FORM GROWTH OF A RED PINE PLANTATION. L. S. Tech. Note 533, 2 pp. (Processed.) 1958.

(The changes of form in a red pine plantation that had been pruned to 22 to 25 feet were followed by diameter measurements at 2, 4.5, 8, and 12 feet above the ground. Sixteen growing seasons after the first pruning, the 50 pruned trees exhibited no changes in form when compared to 50 unpruned trees. The unpruned trees, however, appeared to have slightly higher diameter growth at all points of measurement.)

Clausen, Knud E., and Rudolf, Paul O. GERMINATION OF 29-YEAR-OLD RED PINE SEED. Univ. Minn. Sch. Forestry, Forestry Note 72, 2pp. (Processed.) 1958.

(Red pine seed stored for 29 years in sealed containers still had some viability when stored in an unheated attic. Storage in a fruit cellar and in a cold room gave better results. In all instances viability has decreased markedly since 10-year results were obtained.)

* Conover, D. F. EARLY THINNINGS HAVE INCREASED FORKING IN A NORTHERN HARDWOOD STAND. L. S. Tech. Note 532, 2 pp., illus. (Processed.) 1958.

(Nineteen years after thinning an 11-year-old American elm and sugar maple stand, crop-tree forking has increased in direct relation to the intensity of treatment.)

* Available for distribution.

- * Cooley, John H., and Lord, W. B. A STUDY OF ASPEN-BALSAM FIR CUTTING METHODS IN NORTHERN WISCONSIN--FIVE-YEAR RESULTS. Jour. Forestry 56: 731-736, illus. 1958.
(A progress report on harvest cuttings in a mixed aspen-balsam fir stand. Cutting methods included complete clear cutting of aspen, cutting all aspen having 2 or more 100-inch bolts, cutting all aspen having 3 or more 100-inch bolts, and cutting aspen having one 100-inch bolt. Complete clear cutting resulted in maximum growth of balsam fir, but a 2-stick or 3-stick limit is considered more practical.)
- * Cross, Robert L. GROWTH, VIGOR, AND MORTALITY OF RESIDUAL HEMLOCK-HARDWOOD FOLLOWING A PARTIAL CUTTING. L. S. Tech. Note 526, 2 pp. (Processed.) 1958.
(Hemlock mortality was slight and limited to the first 7 years after cutting. The hardwoods had less mortality, but it continued throughout the entire period. During the last 5 years the hemlock trees classed as normal have increased in diameter growth while the hardwoods have decreased.)
- * Guilkey, Paul C. MANAGING RED PINE FOR POLES IN LOWER MICHIGAN. L. S. Sta. Paper 57, 21 pp., illus. (Processed.) 1958.
(The number of trees in Lower Michigan that are suitable for utility poles was estimated at 215,000, with a potential supply of 1.6 million poles from trees now between 5.0 and 9.5 inches d.b.h. The major pole defects are sweep, caused mainly by snow damage to sapling-sized trees, and crook, which apparently is caused by ice damage to young stands. Knots and limbiness, the other common defects, can be reduced by maintaining stand densities at 140 square feet of basal area per acre or more.)
- * Heinselman, M. L. WIND-CAUSED MORTALITY IN MINNESOTA SWAMP BLACK SPRUCE IN RELATION TO CUTTING METHODS AND STAND CONDITIONS. Soc. Amer. Foresters Proc. 1957: 74-77, illus. 1958.
(Stem breakage and uprooting by wind were the most frequent causes of mortality in a cutting study near Big Falls, Minn. Losses were minor in clear-cut strips and patches and in light partial cuttings. Only heavy partial cuttings by the shelterwood system caused serious losses, and then only in tall old stands on good sites, with exposure to the west.)
- * Rudolf, Paul O. 1957 FOREST TREE SEED CROP ABOUT AVERAGE IN THE LAKE STATES. L. S. Tech. Note 540, 2 pp. (Processed.) 1958.
(Seed crops for the principal forest tree species are listed in percentage of full crops for northern Minnesota, northeastern Wisconsin, central Upper Michigan, Lower Michigan, and north central North Dakota. The pines generally had unusually good crops.)
- * Skilling, D. D. WOUND HEALING AND DEFECTS FOLLOWING NORTHERN HARDWOODS PRUNING. Jour. Forestry 56: 19-22, illus. 1958.
(A study of the importance of healing rates, lumber defects, and epicormic branching following artificial pruning of an 11-year-old stand of northern hardwoods. Showed that no particular problems exist.)
- * Stoeckeler, J. H. PRELIMINARY OBSERVATIONS OF PERENNIAL LUPINE AS A COVER CROP IN FIELD-PLANTING SITES AND FOREST NURSERIES IN WISCONSIN. Soil Sci. Soc. Amer. Proc. 22: 170-173, illus. 1958.
(Perennial lupines, introduced from Europe and tested as a cover crop in the field and in forest nurseries, show promise as a leguminous soiling crop on moderately acid forest soils in Wisconsin if grown for at least 2 or 3 years. They will produce 1 to 2 tons of organic bulk per acre.)

Genetics

- * Lake States Forest Experiment Station. PROCEEDINGS OF THIRD FOREST TREE IMPROVEMENT CONFERENCE SEPT. 17, 18, 1957. L. S. Sta. Paper 58, 87 pp., illus. (Processed.) 1958.

(Contains papers on applying tree improvement practices in the Lake States and recent advances in tree improvement in the Lake States and other regions.)

- * Larson, Philip R. EFFECT OF GIBBERELIC ACID ON FORCING HARDWOOD CUTTINGS FOR POLLEN COLLECTION. L. S. Tech. Note 538, 2 pp. (Processed.) 1958.

(Flower-bearing cuttings of red maple, paper birch, bigtooth aspen, quaking aspen, and pin cherry treated with gibberellic acid broke dormancy earlier and developed more rapidly than controls did.)

McCulley, Robert D. FOREST TREE IMPROVEMENT IN THE LAKE STATES. Wis. Christmas Tree Prod. Assoc. Bul. 15: 3. Sept. 1958.

(Brief comments on forest tree improvement research in the Lake States and its potential value for Christmas tree growers.)

- * FOREST TREE IMPROVEMENT ACTIVITIES AT THE LAKE STATES STATION DURING THE PAST TWO YEARS. In Third Lake States Forest Tree Improvement Conf. Proc., L. S. Sta. Paper 58: 30-34. (Processed.) 1958.

(Discusses Station projects during the past 2 years in physiology, white spruce grafting and breeding, the nursery sowing of exotic species of known origin, the assembling of seed of known origin of white spruce and eastern white pine from their entire ranges, studies of blister rust races, and the maintenance of older seed source, hybrid pine, and species test plots. Plans are to expand genetics work.)

- * Nienstaedt, Hans. HEIGHT GROWTH IS INDICATIVE OF THE RELATIVE FROST RESISTANCE OF HEMLOCK SEED SOURCES. L. S. Tech. Note 525, 2 pp., illus. (Processed.) 1958.

(The severity of fall frost damage to 17 seed sources of hemlock grown in northern Wisconsin was closely correlated to the climate at the location where the seed originated. Relative resistance to frost injury could be predicted on the basis of seedling growth under controlled indoor conditions.)

NEW TESTS FOR DISEASE RESISTANCE IN TREES ARE NEEDED. Der Zuchter Supp. 4: 84-87. 1957.

(It is suggested that studies of the factors--particularly the chemical factors--causing disease resistance may reveal new methods for testing the resistance of host tissue directly. Possible methods of approach to such studies are discussed.)

- * RECEPTIVITY OF FEMALE STROBILI OF WHITE SPRUCE. Forest Sci. 4: 110-115, illus. 1958.

(The period of receptivity of female strobili in white spruce was found to coincide with pollen shedding and to last 3 to 5 days. It is quite uniform on an individual tree and an entire tree can therefore be pollinated successfully in a single operation, at the time of maximum pollen shedding.)

- * ; Cech, Franklin C.; Mergen, Francois; Wang, Chi-Wu; and Zak, Bratislav. VEGETATIVE PROPAGATION IN FOREST GENETICS RESEARCH AND PRACTICE. Jour. Forestry 56: 826-839, illus. 1958.

(Reviews some of the more recent literature on the grafting, air-layering, and rooting of cuttings of forest trees. Our lack of understanding of the fundamentals controlling these processes is stressed, and a plea is made for more basic research on the subjects.)

Rudolf, Paul O. HIGHLIGHTS OF CURRENT FOREST TREE IMPROVEMENT ACTIVITIES IN THE LAKE STATES. Northeast. Forest Tree Impr. Conf. Proc. 5: 11-13. (Processed.) 1958.

(Brief summary of forest tree improvement activities by all agencies in the Lake States.)

PROSPECTS FOR TREE IMPROVEMENT OF NORTHERN HARDWOOD SPECIES. The Timber Prod. 13: 2-3, illus. 1958.

(The present potential of northern hardwoods can be improved by selection and controlled breeding of the best individuals, by crossing races within a species, and by crossing species within a genus. First attention probably should be directed to sugar maple, yellow birch, and basswood.)

_____, and Nienstaedt, Hans. SPRUCE IMPROVEMENT RESEARCH AT THE LAKE STATES FOREST EXPERIMENT STATION--AN OUTLINE. Northeast. Forest Tree Improvement Conf. Proc. 5: 54-57. (Processed.) 1958.

(Brief summary of Station's studies in provenience, ecotypic variation, selection, and breeding of spruces.)

- * _____, and Slabaugh, Paul E. GROWTH AND DEVELOPMENT OF 12 SEED SOURCES OF NORWAY SPRUCE IN LOWER MICHIGAN (15-YEAR RESULTS). L. S. Tech. Note 537, 2 pp. (Processed.) 1958.

(Various European-origin Norway spruce were compared by lot and found to vary widely in survival, height growth, and injury according to seed origin.)

- * _____, and _____ GROWTH AND DEVELOPMENT OF 10 SEED SOURCES OF SCOTCH PINE IN LOWER MICHIGAN (15-YEAR RESULTS). L. S. Tech. Note 536, 2 pp. (Processed.) 1958.

(Various European-origin Scotch pine were compared by lot and found to have significant differences in total height growth, and varying susceptibility to insect attack.)

- * Stoeckeler, J. H. IMPROVEMENT OF STOCK QUALITY IN THE FOREST NURSERY. In Third Lake States Forest Tree Improvement Conf. Proc., L. S. Sta. Paper 58: 8-15. (Processed.) 1958.

(Stock quality in the nursery can be improved by use of proper age classes, fertilization, low density of seeding, culling, proper watering and weeding, root pruning, and use of the proper seed source.)

- * Zasada, Zigmond A. APPLYING FOREST TREE IMPROVEMENT PRACTICES IN SILVICULTURE. In Third Lake States Forest Tree Improvement Conf. Proc., L. S. Sta. Paper 58: 15-18. (Processed.) 1958.

(Although a good rate of growth can be maintained under several methods of cutting and over a wide range of stocking, little is known as to what is happening to the stands genetically. The geneticist must make his information on distinguishing good and poor trees available in simple language so the forest manager can use it.)

Soils, Water, and Shelterbelts

- * Bay, Roger R. CUTTING METHODS AFFECT SNOW ACCUMULATION AND MELT IN BLACK SPRUCE STANDS. L. S. Tech. Note 523, 2 pp., illus. (Processed.) 1958.

(Data on snow depth and water content indicated that cutting narrow east-west strips in black spruce resulted in higher total accumulation of snow and a reduced rate of melt in the spring. Large open areas lost their snow most rapidly.)

- * _____ FOREST TYPE AFFECTS SNOW PACK. Jour. Soil and Water Conserv. 13: 129-130, illus. 1958.

(Snow depth and water content measurements were collected in a red pine plantation and an adjacent brushy aspen area. During the spring melt period more snow was present under the plantation canopy and snow melt was prolonged.)

- * _____ OCCURRENCE AND DEPTH OF FROZEN SOIL. Jour. Soil and Water Conserv. 13(5): 232-233, illus. 1958.

(Forest cover is beneficial in reducing the formation of concrete frost. A mixed white pine-hardwood stand and an aspen stand were more effective in reducing frost formation than was a dense balsam fir stand.)

Stoeckler /Stoeckeler/, J. H. TREES PAY FARM BENEFITS. Conserv. Volunteer 21 (123): 26-31, illus. 1958.

(Cites the value of field shelterbelts in reducing wind erosion, trapping snow, and reducing evaporation.)

- * _____, and Thames, J. L. THE LAKE STATES PENETROMETER FOR MEASURING DEPTH OF SOIL FREEZING. Soil Sci. 85: 47-50, illus. 1958.

(A frost penetrometer is described consisting of a steel rod calibrated in inches and a dead-weighted driving hammer. It is useful in determining depth of soil freezing to a depth of 12 to 15 inches.)

Voigt, G. K., Heinselman, M. L., and Zasada, Z. A. EFFECT OF SOIL CHARACTERISTICS ON THE GROWTH OF QUAKING ASPEN IN NORTHERN MINNESOTA. Soil Sci. Soc. Amer. Proc. 21: 649-652, illus. 1958.

(Aspen soils in northern Minnesota were found to have a wide range of replaceable bases and other fertility factors. The average annual growth of aspen on soils with high levels of calcium, magnesium, potassium, and nitrogen was over four times greater than that on soils with low fertility. Foliar analyses showed a close relation between soil fertility and the presence of calcium, magnesium, and potassium in aspen leaves.)

_____, Stoeckeler, J. H., and Wilde, S. A. RESPONSE OF CONIFEROUS SEEDLINGS TO SOIL APPLICATIONS OF CALCIUM AND MAGNESIUM FERTILIZERS. Soil Sci. Soc. Amer. Proc. 22: 343-345. 1958.

(Yellowing of the outer needle ends of pine seedlings growing in several northern Wisconsin nurseries was corrected by applying dolomitic limestone at 1 ton per acre. The deficiency symptoms were attributed to inadequate amounts of magnesium and calcium.)

Weitzman, Sidney, and Bay, Roger R. WINTER SNOW AND WATER SUPPLY. Conserv. Volunteer 21(126): 45-48, illus. 1958.

(Reports on snow accumulation and melt under different cover conditions. A pine plantation delayed snow melt longer in the spring than did an adjacent aspen stand. Observations in natural stands showed a mixed pine-hardwood cover most effective. Snow disappeared most rapidly from aspen land.)

Fire

Dickerman, M. B. FIRE RESEARCH IN THE LAKE STATES. U. S. Forest Serv., R-9 Fire Meeting Proc. (1958): 17-21 and 6 charts. (Mimeo.) 1958.

(Discusses fire research and its relation to other forest research in the Lake States. Points out that a greater fire research effort is needed to aid in protecting the expanding acreage of coniferous plantings, to aid in making our protection organizations more effective, and to minimize hazards related to forest production and allow appropriate use of fire for silvicultural purposes.)

- * Gaylord, George, and Roe, E. I. SODIUM BORATES SHOW PROMISE FOR GRASS CONTROL. L. S. Tech. Note 515, 2 pp. (Processed.) 1958.

(A commercial mixture of sodium tetraborates and chlorophenyl dimethyl urea, known as Ureabor, applied to upland sandy soil at the rate of 650 pounds per acre killed all the grass and other vegetation and kept the area bare for 2 years.)

- * _____ and _____ TESTS OF SOME CHEMICALS FOR GRASS CONTROL ON FIREBREAKS. L. S. Tech. Note 516, 2 pp. (Processed.) 1958.

(Ureabor, a mixture of sodium tetraborates and chlorophenyl dimethyl urea, proved most effective of four chemicals, each tested at two levels, in not only killing grass and herbs but in keeping these from re-invading fire breaks on upland loamy sand.)

- * LaMois, Loyd. FIRE FUELS IN RED PINE PLANTATIONS. L. S. Sta. Paper 68, 19 pp., illus. (Processed.) 1958.

(Describes the quantities, by weight, of fire fuels in red pine plantations as represented by grass and herbaceous ground cover, dead branches, and needle litter. How each is affected by stand density, site quality, and age.)

_____ TREE FARMS NEED FIRE PROTECTION. Forest and Farm 1(1): 12-13. 1958.

(Points out that fire invariably does some damage to forest land and that the potential for serious damage warrants protective measures, even on a farm-scale forest. The article mentions a few things that can be done to minimize chances of loss from fire.)

McCulley, Robert D. USE OF FIRE IN FOREST MANAGEMENT. U. S. Forest Serv., R-9 Fire Meeting Proc. (1958): 43-49. (Mimeo.) 1958.

(Outlines some of the general relationships between fire and timber production, discusses some of the principles involved, illustrates them with examples from various parts of the country, and draws some inferences about the use of fire in the Lake States.)

Forest Insects

- * Bean, J. L. THE USE OF LARVAEVORID MAGGOT DROP IN MEASURING TRENDS IN SPRUCE BUDWORM POPULATIONS. Annals Ent. Soc. Amer. 51(4): 400-403, illus. 1958.

(Presents a sampling method whereby an estimate of significant difference between budworm populations can be determined for any 2 years within the same area and also for any two areas during the same period.)

- * Ewan, H. G. SOME EFFECTS OF TEMPERATURE EXTREMES ON SARATOGA SPITTLEBUG POPULATION. L. S. Tech. Note 519, 2 pp., illus. (Processed.) 1958.

(Hot, dry weather in 1956 and late spring frosts in 1957 sharply reduced nymphal populations in some areas in Wisconsin and Upper Michigan and eliminate need for control operations.)

- * THE USE OF THE HOST SIZE AND DENSITY FACTOR IN APPRAISING THE DAMAGE POTENTIAL OF A PLANTATION INSECT. Tenth Intl. Congress Ent. Proc. 4: 363-367, illus. 1958.
(An appraisal technique for predicting Saratoga spittlebug damage in red pine plantations. The insect population, measured during the nymphal stage on a 1/10-milacre basis, is adjusted to a tree size and density factor to estimate the damage potential.)
- * Jaynes, H. A., and MacAloney, H. J. THE WHITE-PINE WEEVIL. U. S. Forest Serv., Forest Pest Leaflet 21, 7 pp., illus. 1958.
(A brief account of the life history, description of stages, evidence of infestation, and damage caused; and suggestions for controlling this important plantation insect pest.)
- * Miller, William E., and Haynes, Dean L. CONTROL OF THE EUROPEAN PINE SHOOT MOTH WITH CONCENTRATED DDT SPRAYS. L. S. Tech. Note 543, 2 pp., illus. (Processed.) 1958.
(Good control of the shoot moth was obtained by using air-blast equipment to apply 2½ percent DDT at 40 gallons of spray per acre. This type equipment generates a high velocity blast of air to carry spray, thereby making it possible to reduce the quantity of liquid in the spray mixture. The concentrated mist-blower spray accomplished practically the same result with one-tenth the spray volume of the conventional hydraulic method for shoot moth control.)
- * and TIMING DDT SPRAYS IN THE SPRING FOR EUROPEAN PINE SHOOT MOTH CONTROL. L. S. Tech. Note 542, 1 p. (Processed.) 1958.
(Timing tests with DDT sprays were carried out in the spring to determine the full extent of time available for spring spraying to control the European pine shoot moth. Good control was obtained with sprays containing 2 pounds of actual DDT per 100 gallons of water applied over a period coinciding with the full month of April. This period included the 2 weeks before and 2 weeks after the beginning of external larval activity.)
- Schmiege, Donald C. THE PINE ROOT COLLAR WEEVIL--A THREAT TO YOUNG PINE STANDS. Ent. Soc. Amer., No. Central Branch XIII: 13. (Processed.) 1958.
(Widespread damage in pine plantations has come to the attention of land managers as detailed surveys have become common. Life history, habits, and possibilities for control are discussed.)
- , and Anderson, R. L. THE FOREST INSECT AND DISEASE SITUATION, LAKE STATES, 1957. L. S. Sta. Paper 60, 22 pp., illus. (Processed.) 1958.
(A cooperative report based on surveys conducted by Federal, State, and private agencies in 1957.)
- Waters, W. E., Heller, R. C., and Bean, J. L. AERIAL APPRAISAL OF DAMAGE BY THE SPRUCE BUDWORM. Jour. Forestry 56: 269-276, illus. 1958.
(Two methods--direct aerial observation and airphoto interpretation--are described and compared. Both methods were found to be useful, but accuracy depends greatly on the skill and experience of the observer making the damage estimates.)

Forest Diseases

- * Anderson, Gerald W. HYPOXYLON INFECTION NOT GREATLY INFLUENCED BY SEX OF ASPEN TREES. L. S. Tech. Note 535, 1 p. (Processed.) 1958.
(Discusses results of a survey in which 495 aspen trees were checked for sex and the presence or absence of Hypoxylon canker infection.)

_____ and Anderson, Neil A. CANKER ON THE ASPEN. Conserv. Volunteer 21(121): 62-64, illus. 1958.
(Describes the disease, its life cycle, and impact on aspen in the State. Some relationships between level of infection and stand characteristics are discussed.)
- * _____ and Anderson, Ralph L. THE LOCAL SPREAD OF OAK WILT, 1955 TO 1957. L. S. Tech. Note 521, 1 p. (Processed.) 1958.
(Little change noted in enlargement rate of oak wilt infection centers from 1955 to 1957.)
- * _____ and _____ THE LONG-DISTANCE SPREAD OF OAK WILT, 1955 to 1957. L. S. Tech. Note 520, 1 p. (Processed.) 1958.
(Establishment rate of new infection centers shows little variation over a 3-year period.)
- Anderson, Ralph L. THE MAPLE BLIGHT SITUATION. Timber Prod. Assn. Monthly Bul. 14(3): 2. 1958.
(Discusses the present status of research on the problem and the threat presented by the disease.)
- * Baxter, Dow V., and Hesterberg, Gene A. FUNGI ASSOCIATED WITH DECAY IN SUGAR MAPLE FOLLOWING LOGGING INJURY. L. S. Tech. Note 528, 2 pp. (Processed.) 1958.
(Decay in maple following logging injury is caused by fungi not considered of primary importance in causing defect in undisturbed forests.)
- * Benzie, John W. A RED PINE PLANTATION PROBLEM IN UPPER MICHIGAN. L. S. Tech. Note 524, 2 pp. (Processed.) 1958.
(Describes the symptoms found in a red pine plantation with poor survival. Although dead branches were the most common, they were not associated with survival as were cankers and dead tops. Survival was related to seed source, especially in the younger plantations where mortality was greatest. Effort is now directed toward the identification of the cankers.)
- * Godman, R. M. CHANGES IN YELLOW BIRCH TOP-DYING, UPPER MICHIGAN, 1954-1957. L. S. Tech. Note 527, 2 pp., illus. (Processed.) 1958.
(Top dying has continued to improve in virgin and moderately cut stands since the first year after it occurred. It increased in heavily cut stands until the third year where it has stabilized, with about 80 percent of the trees affected.)
- Guilkey, Paul C.; Rudolph, Victor J.; and Sheppard, George. EFFECTS OF SWEETFERN RUST ON THE GROWTH OF YOUNG JACK PINE IN NORTHERN LOWER MICHIGAN. Jour. Forests 56: 900-903. 1958.
(Height and diameter growth of trees with basal cankers in two 13-year-old plantations were not significantly different from disease-free trees.)

No mortality was attributable to the rust, the trees apparently being infested in the nursery. Unless wood-rotting fungi enter through the exposed dead wood, no significant loss in wood quality or usability is expected.)

* King, D. B. INCIDENCE OF WHITE PINE BLISTER RUST INFECTION IN THE LAKE STATES.

L. S. Sta. Paper 64, 12 pp., illus. (Processed.) 1958.

(A special rust infection incidence survey in the three Lake States shows that in the low-hazard zone an average of 0.6 percent of the pines is lost in 5 years, whereas in the high-hazard zone the 5-year loss averages 6.3 percent. Allowing for the fact that pines infected by the rust after reaching sawlog size generally continue to live and grow for long periods before dying, a table is presented showing the estimated proportion of present unprotected stands that will survive infection during a 100-year rotation by present age of stand and hazard zone.)

Schmiege, Donald C., and Anderson, R. L. THE FOREST INSECT AND DISEASE SITUATION, LAKE STATES, 1957. L. S. Sta. Paper 60, 22 pp., illus. (Processed.) 1958. (Also listed under Forest Insects.)

(A cooperative report based on surveys conducted by Federal, State, and private agencies in 1957.)

Van Arsdel, E. P. SMOKE MOVEMENT CLARIFIES SPREAD OF BLISTER RUST FROM RIBES TO DISTANT WHITE PINES. (Abs.) Bul. Amer. Met. Soc. 39(8): 442-443. 1958.

(Abstract of a paper presented at a national meeting. Discusses reasons for long-distance spread of rust spores from swamp Ribes to white pine.)

_____, Tullis, E. C., and Panzer, J. D. MOVEMENT OF AIR IN A RICE PADDY AS INDICATED BY COLORED SMOKE. Plant Dis. Rptr. 42(6): 721-725, illus. 1958.

(The release of colored smoke in a rice paddy demonstrated variations in air movement. Updrafts and downdrafts were produced during periods of sunlight over warmed and shaded areas. In still air at dawn a smoke drift of about 100 feet per minute was noted. It is suggested that a correlation may exist between local air movement and fungus spread.)

Forest Wildlife

Krefting, L. W., and Hansen, H. L. COMPARISON OF WINTER AND SPRING APPLICATION OF 2,4-D TO INDUCE REGROWTH OF MOUNTAIN MAPLE FOR DEER BROWSE. Univ. Minn., Sch. Forestry, Minn. Forestry Notes 66, 2 pp. (Processed.) 1958.

(Winter applications of 2,4-D top-kill the aerial stems of mountain maple more effectively and with less regrowth both in numbers and height of sprouts than do spring applications.)

* Stoeckeler, J. H.; Keener, John M; and Strothmann, R. O. DEER BROWSE PRODUCTION FROM FELLED TREES IN THE NORTHERN HARDWOOD-HEMLOCK FOREST TYPE. Jour. Forestry 56: 416-421, illus. 1958.

(New growth of dormant hardwood tops was clipped and needles of hemlock were stripped to simulate winter browsing by deer after logging operations. The former yielded about 13 pounds and the latter 117 pounds of fresh browse per square foot of basal area of pole-and sawlog-size trees cut. The amount is two to three times higher in young 1- to 5-inch diameter hardwoods than in older stands.)

Silvics

(The eight reports listed below briefly summarize knowledge concerning the distribution, habitat conditions, life history, special features, and genetic factors of the designated tree species. The Station prepared and issued similar reports last year on seven other species.)

- * Godman, R. M. SILVICAL CHARACTERISTICS OF NORTHERN WHITE-CEDAR (THUJA OCCIDENTALIS L.). L. S. Sta. Paper 67, 17 pp., illus. (Processed.) 1958.
- * Nienstaedt, Hans. SILVICAL CHARACTERISTICS OF WHITE SPRUCE (PICEA GLAUCA (MOENCH) VOSS.). L. S. Sta. Paper 55, 23 pp., illus. (Processed.) 1958.
- * Roe, Eugene I. SILVICAL CHARACTERISTICS OF BALSAM POPLAR (POPULUS BALSAMIFERA L.). L. S. Sta. Paper 65, 17 pp., illus. (Processed.) 1958.
- * Rudolf, Paul O. SILVICAL CHARACTERISTICS OF JACK PINE (PINUS BANKSIANA LAMB.). L. S. Sta. Paper 61, 31 pp., illus. (Processed.) 1958.
- * Scholz, Harold F. SILVICAL CHARACTERISTICS OF AMERICAN BASSWOOD (ILIA AMERICANA L.). Sta. Paper 62, 17 pp., illus. (Processed.) 1958.
- * _____ SILVICAL CHARACTERISTICS OF SLIPPERY ELM (ULMUS RUBRA MUHL.). L. S. Sta. Paper 59, 14 pp., illus. (Processed.) 1958.
- * Slabaugh, Paul E. SILVICAL CHARACTERISTICS OF BIGTOOTH ASPEN (POPULUS GRANDIDENTATA MICHX.). L. S. Sta. Paper 63, 16 pp., illus. (Processed.) 1958.
- * _____ SILVICAL CHARACTERISTICS OF BLACK MAPLE (ACER NIGRUM MICHX. F.). L. S. Sta. Paper 66, 9 pp., illus. (Processed.) 1958.

Estimation of Timber Volume, Growth, and Yield

- * Cooley, John H. SITE INDEX CURVES FOR PAPER BIRCH IN NORTHERN WISCONSIN. L. S. Tech. Note 541, 2 pp., illus. (Processed.) 1958.
(Site index curves for paper birch based on measurements taken on 108 plots. Site indices at 50 years ranging from 34 feet to 77 feet were observed.)

Timber Resource and Production Statistics

- * Cunningham, R. N.; Horn, A. G.; and Quinney, D. N. MINNESOTA'S FOREST RESOURCES. U. S. Forest Serv., Resource Rpt. No. 13, 52 pp., illus. 1958.
(Presents a resumé of Minnesota's forest statistics. Through interpretation and analysis it points up problems confronting forest industry and land managers. Shows that cutting could be increased 50 percent over 1953, but access roads and an active sales campaign are needed to stimulate cutting of overmature timber on public lands. Need for increased planting of softwoods is emphasized.)
- Findell, Virgil E., Chase, Clarence D., and Horn, Arthur G.
- * TIMBER RESOURCES OF THE MENOMINEE-GRAND MARAIS BLOCK, UPPER PENINSULA, MICH. Mich. Dept. Conserv., 74 pp., illus. 1957. (Processed.)
- * TIMBER RESOURCES OF THE NEWBERRY-DRUMMOND ISLAND BLOCK, UPPER PENINSULA, MICH. Mich. Dept. Conserv., 57 pp., 1957. (Processed.)

(Each of the two preceding reports presents data for forest area, timber volume, growth, allowable cut, and timber cut for the Block and, in some cases, for each county.)

- * Findell, V. E., and Pfeifer, R. E. FOREST AREA IN MICHIGAN COUNTIES. L. S. Tech. Note 545, 2 pp. (Processed.) 1958.

(Presents total land area and commercial and noncommercial forest area by county.)

- * Horn, A. G. LAKE STATES PULPWOOD PRODUCTION REMAINS HIGH--HARDWOOD CUT CLIMBS, 1957. L. S. Tech. Note 529, 2 pp. (Processed.) 1958.

(Shows pulpwood production and destination of wood by species in each of the three Lake States. Also shows imports from other states and Canada.)

- * TREND OF PULPWOOD HARVEST UP IN WISCONSIN, PARTICULARLY IN CENTRAL AREA. L. S. Tech. Note 531, 1 p., illus. (Processed.) 1958.

(Compares the 1957 cut of Wisconsin pulpwood with that of 1948. Highlights the cuts by species and districts.)

- * Office of Iron Range Resources and Rehabilitation and Lake States Forest Experiment Station. THE FOREST RESOURCE OF CENTRAL MINNESOTA. Office Iron Range Res. & Rehab., 48 pp., illus. 1958.

(Presents forest areas, timber volumes, growth, allowable cut, and timber cut for the block and, insofar as feasible, for each of the 21 counties in the block.)

Quinney, Dean N., Chase Clarence D., and Horn, Arthur G.

- * TIMBER RESOURCES, MIO BLOCK, LOWER PENINSULA, MICHIGAN. Mich. Dept. Conserv., 48 pp., 1957. (Processed.)

- * TIMBER RESOURCES, NORTH TIP BLOCK, LOWER PENINSULA, MICHIGAN. Mich. Dept. Conserv., 88 pp., illus. 1957. (Processed.)

(Each of the two reports listed above presents data for forest area, timber volume, growth, allowable cut, and timber cut for the Block and, in some cases, for each county.)

- * Stone, Robert N. FOREST PLANTING TRENDS IN NORTHERN LOWER MICHIGAN. L. S. Tech. Note 539, 2 pp., illus. (Processed.) 1958.

(Presents forest plantings by ownership, species groups, and decades.)

- * FOREST PLANTINGS IN NORTHERN LOWER MICHIGAN BY COUNTY. L. S. Tech. Note 544, 2 pp., illus. (Processed.) 1958.

(Presents forest plantings by ownership, species group, and county for 1900 to 1956.)

- * Vasilevsky, Alexander M. NET TIMBER VOLUME BY SPECIES AND COUNTIES ON COMMERCIAL FOREST LAND IN MINNESOTA. L. S. Tech. Note 522, 2 pp., illus. (Processed.) 1958.

(Presents net sawtimber volume and total net volume in cords by species and counties or county group.)

Wisconsin Conservation Department and Lake States Forest Experiment Station.

- * FOREST RESOURCES OF LINCOLN COUNTY. Wis. Conserv. Dept., Forest Inventory Publ. 31, 36 pp., illus. (Processed.) 1958.
- * FOREST RESOURCES OF PRICE COUNTY. Wis. Conserv. Dept., Forest Inventory Publ. 32, 31 pp., illus. (Processed.) 1958.
- * FOREST RESOURCES OF 32 NORTHERN AND CENTRAL WISCONSIN COUNTIES-- (STATISTICAL REPORT). Wis. Conserv. Dept., Forest Inventory Publ. 33, 25 pp. (Processed.) (Summarizes forest area, timber volume, growth, and allowable cut for the county or group of counties indicated.)

Timber Utilization and Marketing

- * Boldt, Charles E. KILN CORDWOOD CAN BE SEASONED RAPIDLY BY TRANSPIRATION. L. S. Tech. Note 530, 2 pp., illus. (Processed.) 1958.

(Felling sugar maple trees in August and not bucking them until their leaves withered and dried (about 25 days) resulted in a moisture content 13 percent lower than could be obtained by the usual bucking immediately after felling and air drying for the same period.)

Neetzel, John R., and Christopherson, C. H. FENCE POSTS FROM TREE FARMS. Keep Minn. Green 3(3): 7, 10. 1958.

(Many farmers cut fence posts from their woodlots and tree farms. If the posts are to be used untreated, naturally durable species like black locust or white or bur oak should be used. If the home-cut posts are to be treated, species that will take treatment readily (jack and red pines and red oak) should be selected.)

Sullivan, E. T., Neetzel, J. R., and Salzman, J. A. WOOD CHIP LIVESTOCK BEDDING--AN OUTLET FOR LOW-QUALITY FARM TIMBER? Minn. Farm and Home Sci. XVI (1): 7, 9, 17.

(While wood chips, pound for pound, do not absorb as much water as straw or shredded cornstalk, they do compare favorably with sawdust, shavings, and ground corn cobs, and could in the future provide an outlet for low-quality wood now so abundant in farm woodlots.)

Warner, John R.

- * THE TWIN CITIES LUMBER AND WOOD PRODUCTS INDUSTRIES AS USERS OF WOOD. L. S. Tech. Note 517, 2 pp., illus. (Processed.) 1958.

- * MISCELLANEOUS MANUFACTURING INDUSTRIES IN THE TWIN CITIES AS USERS OF WOOD. L. S. Tech. Note 518, 2 pp., illus. (Processed.) 1958.

(Each of these Notes discusses briefly the species, volume, form, source, and use of lumber purchased in 1956 by firms in the designated industries.)

- * LUMBER PURCHASES BY SEVEN MANUFACTURING INDUSTRY GROUPS IN MINNEAPOLIS AND ST. PAUL, 1956. L. S. Tech. Note 534, 2 pp., illus. (Processed.) 1958.

(A summary of seven earlier Technical Notes, each of which reported the lumber purchases and use of individual manufacturing industry groups in the Twin Cities during 1956.)